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Launch Vehicle Effluent Measurements During the September 5, 1977, Titan III Launch at Air Force Eastern Test Range

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16 Abstract

Airborne effluent measurements and cloud physical behavior for the September 5, 1977, Titan III launch from the Air Force Eastern Test Range, Florida, are presented. The monitoring program included airborne effluent measurements in situ in the launch cloud, visible and infrared photography of cloud growth and physical behavior, and limited surface collection of rain samples. Effluent measurements included concentrations of HCl, Cl_2, NO, NO_x, and particles as a function of time in the exhaust cloud. In situ particle mass concentration and number density were measured as a function of time and size in the range of 0.05-μm to 30-μm diameter. Measurement results were similar to those of previous launch monitorings. Maximum HCl and NO_x concentrations ranged from 25 ppm and 1000 ppb, respectively, several minutes after launch to around 1 to 3 ppm and 100 to 200 ppb at 100 minutes after launch. Concentrations of Cl_2 were maximum about 2 minutes after launch and by 10 to 15 minutes had decayed to less than 10 ppb (detection limit) Particle measurements showed most of the particles present to be below about 3-μm diameter. Postlaunch analyses of collected particle samples showed significant amounts of Al (some cases Cl) from about 3-μm to 0.04-μm diameter. The format of the paper is data presentation.

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SUMMARY

Airborne effluent measurements and cloud physical behavior for the September 5, 1977, Titan III launch are summarized. The Titan vehicle was launched at 0856 eastern daylight time (EDT) from launch complex 41 (LC-41) at the Air Force Eastern Test Range (AFETR), Florida. This set of measurements is but one of many conducted by the National Aeronautics and Space Administration (NASA) as part of its tropospheric program to study the effect of launch vehicle emissions on tropospheric air quality.

The monitoring program included airborne effluent measurements in situ in the launch cloud, visible and infrared photography of cloud growth and physical behavior, and limited surface collection of rain samples. Effluent measurements included concentrations of hydrogen chloride (HCl), chlorine (Cl_2), oxides of nitrogen (NO and NO_x), and particles as a function of time in the exhaust cloud. Particle mass concentration and number density in the launch cloud were measured as a function of time and size in the range of 0.05- to 30-μm diameter.

Incloud gaseous effluent values were found to be similar to those measured at previous launches. For example, maximum incloud HCl concentrations ranged from about 25 parts per million (ppm) several minutes after launch to 1 to 3 ppm at 100 minutes after launch. Maximum Cl_2 concentrations ranged from about 40 parts per billion (ppb) at 2 to 3 minutes after launch to less than 10 ppb (lower detection limit) at 10 to 15 minutes after launch. Maximum NO_x concentrations were 900 to 1000 ppb at several minutes after launch and about 200 ppb after 100 minutes. Integrating nephelometer measurements showed maximum incloud particle concentrations to be about 1000 $\mu g/m^3$ several minutes after launch to about 100 $\mu g/m^3$ at 100 minutes. A second flight showed little additional decay for maximum incloud effluent concentrations at 180 to 270 minutes after launch. For example, at 270 minutes after launch maximum HCl concentrations were still 1 to 3 ppm, NO_x was 100 to 200 ppb, and particles (nephelometer) were 100 to 200 $\mu g/m^3$. Particle sizing measurements showed mass concentration peaks at 0.05- to 0.1-μm diameter and at 1- to 3-μm diameter. Particle number density measurements confirmed that most particles present in the launch cloud were below 2-μm diameter. Chemical analyses of collected particle samples showed that those which occurred in a diameter range from about 3 μm to 0.4 μm contained significant aluminum (Al) content and in some cases Cl. Cloud imaging data (visible and infrared) were obtained until 40 minutes after launch, after which ambient clouds and haze caused difficulty in identification of the launch cloud from the ambient background. The format of this paper is data presentation.

INTRODUCTION

Since 1972, NASA has been conducting launch vehicle effluent (LVE) measurements at selected NASA and Air Force launches for the purpose of investigating the effect of launch vehicle emissions (mainly, solid rocket motor emissions)

on tropospheric air quality. This tropospheric program is aimed at measuring and predicting the impact of ground clouds produced at launch on the surface air quality. The LVE monitoring program is conducted by the Langley Research Center (LaRC) with intercenter support from Marshall Space Flight Center (MSFC) and John F. Kennedy Space Center (KSC). The goal of the LVE program is to assess the applicability and accuracy of diffusion models for predicting the dispersion of exhaust effluents from NASA's current and future launch vehicles. The objectives of the program are to develop data to be used in the establishment of potential launch constraints and to develop in-house expertise in the areas relating to the environmental impact of launch activities. The approach employed to meet these objectives is that of measuring rocket exhaust products (produced by large, solid rocket motor launch vehicles) at surface level and within the stabilized ground cloud formed in the troposphere as the result of the launch. These exhaust products are mainly HCl in the gaseous and particle phases and particulates (aluminum oxide (Al_2O_3) and debris). These measurements are then used to make direct comparisons with the diffusion models and NASA plume codes that are used to predict effluent composition and concentrations.

From 1972 to midyear 1974, LaRC monitored six launches (refs. 1 to 5) for purposes of developing the measurement techniques and operational procedures for full-scale (land, sea, and airborne) monitoring of four targeted launches in late 1974 and 1975. The four launches were selected in which full-scale measurement and modeling programs would be attempted and model-measurement results intercompared. The HCl data obtained during the four launches are reported in reference 6, and the December 1974 and May 1975 launch results are discussed in detail in references 7 and 8, respectively. After completion of the four full-scale launch monitoring activities, LaRC discontinued such large-scale monitoring but has continued the airborne sampling at a rate of about two launches per year. References 9 and 10 describe other monitoring activities since 1975.

The measurement results for the September 5, 1977, Titan III launch are summarized herein. The purpose of this paper is data presentation. The Titan vehicle was launched from LC-41 at AFETR, Florida. Launch time was 1256 universal time (UT) (0856 EDT). The LVE monitoring experiment included airborne effluent measurements in situ in the launch cloud, visible and infrared photography of cloud growth and physical characteristics, and limited collection of rain samples at the surface.

SYMBOLS

t_0 — reference time for concentration-time plots, min:sec after launch

T — time relative to launch; T - 0 is launch

Abbreviations:

CS-27200 — camera site, Air Force facility 27200

FSSP — forward scattering spectrometer probe

LC-41 — launch complex 41

LVE launch vehicle effluent

ppb parts per billion by volume

ppm parts per million by volume

QCM quartz crystal microbalance cascade impactor

SEM scanning electron microscopy

SRM solid rocket motor

UCS universal camera site

VAB camera site, Vertical Assembly Building

EXHAUST CLOUD DESCRIPTION

A brief description of the ground cloud sampled by the aircraft is presented. Refer to references 5, 8, 11, or 12 for a more detailed cloud discussion.

The Titan III launch vehicle consists of a three-stage core using a liquid propulsion system and two solid rocket motors (SRM) attached on opposite sides of the core. Only the SRM boosters (first 10 to 20 seconds of burn) contribute effluents to the ground cloud because the liquid propulsion system is ignited at altitude. Each of the two SRM boosters has a mass-flow rate at lift-off of about 4160 kg/sec. This mass-flow rate remains relatively constant for the first 20 seconds of burn. This initial exhaust from the SRM boosters generates a ground cloud in the immediate vicinity of the launch pad and, as a result of its heat content, rises to a stabilization altitude where it then drifts and diffuses with the prevailing winds. Stabilization typically occurs within 15 minutes after launch at altitudes between 1000 and 2000 meters, depending upon cloud buoyancy, meteorology, and the mixing-layer height. Initially, the cloud is composed of species from the SRM engine exhaust, debris from the launch pad, and species generated during high-temperature afterburning reactions in the exhaust plume. However, as the cloud rises, stabilizes, and drifts with the wind, it entrains large quantities of atmospheric air, and by the time stabilization occurs, less than 1 percent of the cloud mass is engine exhaust. Main constituents of the stabilized ground cloud are listed in table 1. Incloud concentrations at about 10 to 15 minutes after launch and the sources for each specie are given.

MEASUREMENT PROGRAM

The airborne sampling strategy and instrumentation used in the LVE program has been discussed in previous papers. (See refs. 5, 8, and 13.) A description of the visible photography and infrared imaging instrumentation are available in references 8 and 14. Therefore, only a brief summary of the measurement program is presented herein.

Airborne Sampling Plan

The sampling platform, a twin-engine light aircraft, was airborne at approximately T - 30 minutes. Range safety required the aircraft to be in a holding pattern at an altitude of approximately 1000 meters, approximately 8 km west of the launch pad. Just before T - 0 the aircraft was released from the holding pattern and radar vectored to enter the launch restricted area at T + 1 minute to perform the sampling mission. The sampling plan used by the aircraft was a series of basic downwind and crosswind penetrations of the exhaust cloud, each through the center of the cloud as determined visually by the flight crew. (See fig. 1.) For this mission, 50 penetrations of the exhaust cloud were made. Twenty-eight penetrations were made between T + 2 minutes and T + 100 minutes, after which the aircraft landed for refueling. The remaining 22 penetrations were made between T + 180 minutes and T + 270 minutes. The flight parameters associated with each sampling pass are listed in table 2.

Airborne Instrumentation

The sampling aircraft (ref. 13) was equipped to monitor HCl, suspended particles, NO, NO_x, and Cl_2. Routine flight parameters (altitude, heading, airspeed, etc.) were also measured. Aircraft position for the first 28 sampling passes was obtained by ground radar track of the onboard S-band transmitter beacon. For the second flight the aircraft position was not recorded (beyond radar range). For this second flight the aircraft was vectored to its sampling position by a second aircraft which remained airborne to perform weather modification measurements. As discussed in reference 13, all effluent air samples are taken through specially designed sampling probes located in the nose of the aircraft. These probes extend forward of the flow-field disturbance created by the aircraft, thus collecting undisturbed, free-stream sampling air. The installation of that instrumentation not covered in reference 13 is discussed in references 9 and 15. The characteristics of the effluent monitoring instrumentation for this mission are described in table 3. The operations of each instrument are described in references 13, 15, 16, 17, and 18. (See table 3.) The three different particle instruments characterize the particles in the rocket exhaust cloud in terms of total mass concentration, size distribution, and (to a limited extent) elemental composition as a function of size. An integrating nephelometer was used to measure the total particulate mass concentration as a function of position (time) in the cloud. The 10-stage QCM measured particulate mass concentration ($\mu g/m^3$) as a function of time in 10 particle size (aerodynamic) ranges from 0.05-μm to 25-μm diameter. Size separated elemental analyses were made postflight on particles collected in the cascade impactor by using scanning electron microscopy. The FSSP measured particle number density ($No./cm^3$) as a function of time and size in a size range from 0.5-μm to 45-μm diameter. For this launch, the FSSP sizing range was 2- to 30-μm diameter for passes 1 and 2, 1- to 15-μm diameter for passes 3 to 15, and 0.5- to 7.5-μm diameter for the remaining passes. As discussed in some detail in reference 9, the nephelometer and QCM sampled through a heated inlet to eliminate moisture, whereas the FSSP was located external on the aircraft.

Surface-Level Effluent Measurements

Seventeen rain collectors were deployed at surface level around the launch pad for the purpose of determining the acidity of any droplets originating from or passing through the exhaust cloud. No rain occurred in the vicinity of the pad near launch time, and no droplets were collected.

Cloud Imaging Systems

Metric-tracking cameras (ref. 14) and time-sequence cameras were located at sites UCS-9, USC-2, and CS-27200 (see fig. 2) for purposes of obtaining records of cloud track, rise, growth, and volume. A motion-picture camera was located at site VAB. Infrared scanners (ref. 8) located at sites CS-27200 and VAB provided additional cloud physical data. Approximately 40 minutes of cloud imaging data were obtained at all sites.

DATA RESULTS

The data obtained during the September 5, 1977, LVE measurement operation are presented. Where appropriate, similar data from previous launches are shown for comparison.

Meteorology

Figure 3 shows the meteorological data for the launch. These data are from a rawinsonde released at T + 28 minutes (time nearest launch where sonde data are available) and T - 0 tower surface data.

Cloud Physical Parameters

As stated previously, cloud imaging data were obtained at all sites up until about T + 40 minutes, after which identification of the cloud from ambient background became difficult. Data from the metric-tracking cameras are usually used as the only means of providing cloud-track data. However, the cloud-track data from the metric-tracking cameras for this experiment showed an unusually high initial cloud rise (approximately 1.8 km) to T + 11 minutes with a steep drop to about 1.5 km at T + 13 minutes, a phenomenon not seen during previous experiments. In addition, reports from ground observers did not verify this unusual cloud behavior and aircraft cloud penetrations were nearly 300 meters lower than the metric-tracking data. Examination of the time-sequence photographs, usually used only to provide cloud-volume information, indicated that metric-tracking operators probably included the column cloud as part of the main cloud in their estimation of cloud centroid and rise. A similar circumstance existed near T + 24 minutes in that the metric-tracking data showed a steep increase (200 meters) in cloud altitude from about T + 24 to T + 27 minutes. Again neither ground observers nor aircraft measurements could verify this

occurrence. Examination of the time-sequence film indicated that the metric-tracking operators may have included ambient clouds as part of the ground cloud. Consequently, it was decided to ignore the metric-tracking data and instead use the time-sequence photographs to provide cloud-track data during these time periods. Thus the optical cloud-track data (shown in fig. 4) from T + 2.5 to T + 12.5 minutes and beyond T + 24.5 minutes are from analyses of the time-sequence photographs and the remaining data are from the metric-tracking measurements. Also shown for comparison is the aircraft altitude for those sampling passes up to about T + 34 minutes.

Figure 5 shows the cloud surface trajectory obtained using the same combination of metric-tracking and time-sequence data. The bars on the data indicate the uncertainties in the cloud centroid location. (See ref. 5 for a discussion of data analysis techniques.) Also shown is the aircraft location (radar data, table 2) for those sampling passes up to T + 38 minutes. The comparison between the aircraft data and the optical results is representative of that from previous launch monitorings.

Figures 6 and 7 show cloud-volume results. The data from the camera sites are the time-sequence results. The trajectory of the cloud (approximately northeast) was such that the time-sequence camera from USC-2 was able to photograph the cloud in nearly an along wind direction, whereas those at UCS-9 and CS-27200 obtained crosswind photographs. By applying the previously used techniques (ref. 5) which involved dividing the cloud into elliptical sections with major and minor axes in the along wind and crosswind directions, respectively, two quasi-independent measurements of cloud volume were obtained and are compared in figure 6. No data were obtained between 10 and 26 minutes for the UCS-2 and CS-27200 combination because ambient clouds passed between the camera at CS-27200 and the exhaust cloud during this time period. By considering the assumptions made and the technique applied, the data agree reasonably well, particularly during the early time periods when rapid growth is occurring. The agreement is not so good after 25 minutes. However at this time the cloud was 15 km away from the nearest camera site and the cloud image was so small that a small error in defining the outline of the cloud due to ambient cloud interference or haze could result in a relatively large error in volume. Also shown in figure 6 is cloud volume calculated from aircraft residence time in the cloud during successive along wind and crosswind passes. Aircraft time in the cloud, as measured by the rapid response nephelometer, was used as a basis for determining cloud volume. The cloud was assumed to form into a prolate spheroid with the along wind pass being along the major axis and the crosswind pass being along the minor axis. As shown in figure 6, the cloud volume measured in this manner compares favorably with the optical data. Cloud volume (aircraft data) for the entire measurement operation is shown in figure 7. The aircraft landed and refueled in the T + 1 hour 30 minutes to T + 3 hour time period.

Figures 8 and 9 show a comparison of the September 1977 cloud data with that of other Titan III clouds (all at the Florida launch site). Figure 8 shows that the initial rise rate of the clouds, 4 to 5 m/sec, is essentially the same and thus independent of existing meteorology. However cloud-stabilization altitude is different for the launches and is a function of meteorology. Based on figure 8, stabilization altitudes range from 1 to 2 km with cloud stabilization occurring within 15 minutes after launch. Figure 9 shows the cloud-volume

comparison. The data shown are from both the time-sequence camera and aircraft results.

Airborne Effluent Measurements

Concentration-time data.- Incloud effluent concentrations of HCl, Cl_2, particles (nephelometer), and NO_x measured during each sampling pass are shown in figure 10. The data for NO are not shown because measurements indicate nearly all the NO_x are NO. Zero time t_0 for the abscissa of each plot is shown in the figure and is given in minutes and seconds after launch. The following points are to be considered in the interpretation of the data of figure 10:

(1) Chlorine data are shown only for the first 10 sampling passes. Beyond pass 10 chlorine concentrations are below 10 ppb (detection limit).

(2) No correction for sampling line time-delay effects of the various instruments has been applied to the data. Generally the nephelometer and HCl instruments respond together, whereas the NO_x and Cl_2 data lag by about 10 seconds because the NO_x and Cl_2 instruments are located in the aft passenger cabin, whereas the other two instruments are located in the nose compartment of the aircraft.

For this mission maximum observed HCl concentration was about 27.5 ppm and occurred during pass 1 (T + 2.6 minutes). By about T + 40 minutes, HCl had decayed to about 10 ppm. At completion of the first sampling flight (T + 100 minutes), maximum HCl was about 1 to 3 ppm and showed little additional decay by completion of the second sampling flight at T + 270 minutes. Peak Cl_2 concentration was about 40 ppb (pass 1) and by T + 10 minutes to T + 15 minutes had decayed to 10 ppb, the lower detection limits of the instrument. Maximum NO_x concentrations were of the order of 800 to 1000 ppb for the first few passes and decayed to 200 to 300 ppb by completion of the first sampling flights (T + 100 minutes). Because of noise problems with the NO_x instrument during the second flight, no data are shown; however as was the case for HCl, maximum NO_x concentrations decayed very little during the second flight and at T + 270 minutes were of the order of 100 to 200 ppb. Maximum particulate concentration (nephelometer) was about 900 to 1000 $\mu g/m^3$ for the first flight and rapidly declined to 300 to 400 $\mu g/m^9$ for passes 2 and 3. By T + 100 minutes, maximum particulate concentration had decayed to about 100 to 200 $\mu g/m^3$ and remained at these levels until completion of the mission at T + 270 minutes. The rapid decay from pass 1 to pass 2 (other species showed much smaller decay) is somewhat unexpected. A review of instrument operation has shown no known instrument malfunction or cause for this behavior. Although the particle concentrations are relatively low (as compared with some launches) for pass 2 to pass 50, these low levels have been observed in previous launches. The data of figure 10 are tabulated in the appendix.

The September 1977 airborne data are compared with those of previous Titan III launches in figure 11. The solid-line curves represent the envelope of maximum observed concentrations in each sampling pass for previous Titan III launches.

Particle sizing data.- The size distribution (QCM and FSSP instruments) of particles in the LVE cloud were determined on a per pass basis rather than as a function of time. (The data reduction technique is discussed in ref. 9.) Table 4 shows the QCM data ($\mu g/m^3$) for each size range and for passes 1 to 15. After pass 15 the QCM sensor crystals were saturated (read off scale) with collected samples, and the data are invalid. Figure 12 is a plot of the data. As for the May 1977 data (ref. 9), the QCM data generally show a bimodal size distribution with nodes in the 0.05- to 0.1-µm-diameter range and in the 1- to 3-µm-diameter range. As shown by the data, only a small quantity of mass is above 5-µm diameter. As previously mentioned and as discussed in reference 9, the QCM inlet is heated to reduce moisture and liquid particle saturation of the sensing crystal. The early saturation of the QCM crystals and observed (post-launch laboratory analysis to be discussed) stains around collected particulates suggest that the particle samples may not have been free of moisture. Thus the QCM data for this mission are probably not a measure of the particulate (solid) portion of the particle present in the cloud but include some undefined but measurable portion of the liquid particle present.

The particles collected in each of the 10 stages of the QCM were analyzed by scanning electron microscopy (SEM) to determine the elemental makeup and morphology of the particles according to size. Stage 1 (25-µm diameter) contained three types of amorphous particles: (1) Particles about 12-µm diameter consisting of iron (Fe), tin (Sn), and chlorine (Cl); (2) particles about 18-µm diameter consisting of calcium (Ca) and sulfur (S); and (3) particles about 50-µm diameter consisting of sodium (Na), Al, S, Cl, potassium (K), and Ca. Stages 2 (12.8-µm diameter) and 3 (6.4-µm diameter) showed very few discernible particles. Large stained areas appeared to be left by evaporation of droplets, but none of the residue was identifiable by SEM. In stage 4 (3.2-µm diameter) stained spots similar to the ones in stages 2 and 3 appeared outside the central impaction region. In the central region a large number of discrete spherical particles of uniform size and a few clusters appeared. Most of the particles contained Al and a few contained Cl. Stage 5 (1.6-µm diameter) particles are not as uniform in size as those of stage 4. Spherical particles showed Al only, whereas amorphous particles showed no X-ray spectra. In stage 6 (1.6-µm diameter) the particles are mostly spherical and discrete and consist of Al and some particles are amorphous and contain Al and Ca. In stage 7 (0.4-µm diameter) the particles are spherical and discrete with some clustering. As in stages 5 and 6, the spherical particles contain Al. The amorphous particles consist of Al and Cl. The particles in stages 8, 9, and 10 (0.2- to 0.05-µm diameter) are mostly agglomerates consisting of Cl, S, K, Ca, Fe, and zinc (Zn). In these stages there are a number of relatively large needle-like crystals that show no X-ray spectra. These crystals are believed to be formed during impaction because they are too large to have been transported through the instrument in their present form.

The FSSP sizing data for all 50 sampling passes are shown in figure 13 and table 5. The data are expressed as percentage of particles in a size range relative to the total number of particles sampled. As discussed previously, the FSSP samples particles outside of the aircraft (no inlet probe) and thus is equally sensitive to liquid and particulate particles. As shown in table 5, the size range over which the instrument is sensitive was changed after pass 2 and after pass 15. Based on the FSSP data, the majority (number) of particles

present in the LVE cloud are below 2-μm diameter, and a bimodal distribution is not generally shown.

Note that the operating principles of the various particle instruments (nephelometer, QCM, and FSSP) are different, the instruments are sensitive over different size ranges, and the instrument responses are affected by different factors. Therefore direct comparisons of data from the three different instruments are not easily made. For example, the response of the integrating nephelometer is strongly dependent upon size distribution over a range of approximately 0.2-μm to 10-μm diameter and is essentially zero outside this range. The nephelometer response is further complicated by the light refraction characteristics of the particles. These factors must be considered before comparing the integrating nephelometer data with the other data. If the QCM data are compared with the FSSP data, two factors must be considered: (1) The QCM cascade impactor measures aerodynamic size and is therefore sensitive to mass density, whereas the FSSP measures geometrical size and is sensitive to shape and refractive index; and (2) the QCM inlet is heated so that most of the liquid component is removed from the sample. This is not the case for the FSSP. Owing to the complexity of this problem no attempt is made in this paper to compare qualitatively the results from the various particle instruments.

CONCLUDING REMARKS

The data presented herein were obtained during the September 5, 1977, Titan III launch vehicle effluent (LVE) measurement program. Most data are presented in both tabular and graphical form, in a format easily used and referenced for applications. No data analyses are presented. Where appropriate the September 1977 data are compared with the data base from previous LVE monitoring programs.

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APPENDIX

TABULATION OF AIRBORNE HCl, Cl_2, NO_x, AND NEPHELOMETER DATA

Tables 6 to 55 present the data that are shown graphically in figure 10. Tabulations are for 2-second intervals. The reference time (column 1) refers to the abscissa values in figure 10. Some background data (outside the cloud) shown in the figure have been omitted from the tabulations.

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TABLE 1.- GROUND CLOUD CONSTITUENTS

Specie	Source	Nominal maximum concentration
N_2	Ambient air	Ambient values
O_2	Ambient air	Ambient values
H_2O	Ambient air; launch pad cooling; exhaust	Ambient values
CO_2	Ambient air; exhaust plume afterburning	Ambient values
Particles	Exhaust; pad debris	[a]1000 to 3000 μg/m^3
HCl	Exhaust	[a]5 to 40 ppm
CO	Ambient air; exhaust	[a]<1 ppm
NO	Exhaust plume afterburning	[a]200 to 800 ppb
Cl_2	Exhaust plume afterburning	[a]20 to 40 ppb

[a]Measured values from previous LVE.

TABLE 2.- AIRBORNE SAMPLING PARAMETERS

Pass	Sampling altitude, m (a)	Aircraft heading variation during pass, deg (magnetic)	Aircraft location from LC-41 (b)		Time of pass after launch, min (c)
			km	Azimuth, deg	
1	680 ± 20	26 to 73	1.8	39	2.6
2	859 ± 30	274 to 314	1.4	24	4.3
3	1105 ± 26	2 to 358	2.3	38	6.4
4	1423 ± 6	295 to 304	2.4	46	9.0
5	1485 ± 9	15 to 47	3.6	45	12.3
6	1486 ± 8	280 to 300	3.2	55	14.9
7	1485 ± 8	6 to 35	4.1	54	17.7
8	1419 ± 6	294 to 302	4.8	55	21.9
9	1419 ± 10	24 to 54	6.1	57	25.5
10	1416 ± 10	283 to 299	5.6	60	28.5
11	1419 ± 7	15 to 47	(d)	(d)	31.0
12	1414 ± 7	291 to 395	(d)	(d)	34.3
13	1414 ± 7	26 to 54	7.5	58	37.8
14	1412 ± 6	260 to 304	8.1	58	41.7
15	1384 ± 7	3 to 30	9.0	59	44.6
16	1385 ± 8	290 to 302	9.3	59	48.1
17	1384 ± 6	18 to 33	10.0	57	52.0
18	1350 ± 9	280 to 301	(d)	(d)	55.8
19	1356 ± 3	19 to 53	11.6	57	58.7
20	1351 ± 3	295 to 297	11.6	61	61.7
21	1224 ± 6	17 to 36	15.2	54	66.1
22	1232 ± 6	278 to 306	13.4	52	69.3
23	1210 ± 28	10 to 60	14.1	59	72.2
24	1201 ± 6	291 to 305	15.3	56	75.9
25	1134 ± 8	0 to 15	16.6	57	88.9

[a] Average altitude for pass ± Variation.
[b] Aircraft location at midpoint time of sampling pass.
[c] Midpoint time of sampling pass.
[d] Radar-track data not available.

TABLE 2.- Concluded

Pass	Sampling altitude, m (a)	Aircraft heading variation during pass, deg (magnetic)	Aircraft location from LC-41 (b)		Time of pass after launch, min (c)
			km	Azimuth, deg	
26	1136 ± 9	258 to 303	18.5	56	92.8
27	1133 ± 13	16 to 99	19.1	55	95.4
28	1135 ± 6	282 to 303	18.2	58	98.7
29	1144 ± 8	19 to 25	(e)	(e)	182.6
30	1121 ± 9	22 to 41	(e)	(e)	189.9
31	1116 ± 5	290 to 307	(e)	(e)	194.8
32	1123 ± 8	19 to 88	(e)	(e)	197.4
33	1105 ± 10	260 to 302	(e)	(e)	201.0
34	1109 ± 6	22 to 28	(e)	(e)	207.7
35	1120 ± 20	291 to 308	(e)	(e)	211.5
36	1130 ± 11	19 to 79	(e)	(e)	215.3
37	1127 ± 6	251 to 307	(e)	(e)	219.4
38	1152 ± 19	22 to 57	(e)	(e)	223.6
39	1168 ± 8	281 to 304	(e)	(e)	228.3
40	1166 ± 8	111 to 210	(e)	(e)	230.1
41	1143 ± 22	19 to 63	(e)	(e)	232.3
42	1131 ± 8	297 to 302	(e)	(e)	236.0
43	1129 ± 6	197 to 213	(e)	(e)	237.9
44	1128 ± 8	23 to 31	(e)	(e)	241.3
45	1142 ± 18	290 to 309	(e)	(e)	246.1
46	1148 ± 12	22 to 164	(e)	(e)	249.3
47	1153 ± 5	296 to 301	(e)	(e)	254.2
48	1205 ± 8	19 to 65	(e)	(e)	259.8
49	1201 ± 9	264 to 303	(e)	(e)	263.9
50	1230 ± 10	23 to 84	(e)	(e)	267.6

[a]Average altitude for pass ± Variation.
[b]Aircraft location at midpoint time of sampling pass.
[c]Midpoint time of sampling pass.
[d]Radar-track data not available.
[e]Radar track not made for second sampling flight (passes 29 to 50).

TABLE 3.- INSTRUMENT CHARACTERISTICS

Instrument	Specie	Reference	Range (a)	Detection limit	Response to 90-percent reading, sec
Chemiluminescent	HCl	13, 16, 17	0.5 to 200 ppm	0.5 ppm	1
Chemiluminescent	Cl_2	15	10 ppb to 10 ppm	10 ppb	1 to 5
Chemiluminescent	NO and NO_x	13	0.002 to 5 ppm	0.002 ppm	1
[b]10-stage QCM	Particles	18	0.05- to 25-μm diam	10 $\mu g/m^3$	2
[c]FSSP	Particles	15	0.5- to 45-μm diam	1 particle	------
Nephelometer	Particles	13	>0.4-μm diam	100 particles	.2

[a]Particle and particle instrument range given in particle diam.
[b]Mass concentration at 10 particle size ranges.
[c]Particle number density in 15 size ranges.

TABLE 4.- PARTICULATE MASS CONCENTRATION AS FUNCTION

OF DIAMETER (QCM DATA)

Pass	Mass concentration, $\mu g/m^3$, for diameter, μm, of -									
	0.05	0.1	0.2 (a)	0.4	0.8	1.6	3.2	6.3	12.5	25	Σ-stage
1	144	173	---	67	43	11	65	34	12	34	670
2	104	83	---	6	52	15	162	17	0	52	371
3	26	48	---	8	18	6	51	13	13	15	222
4	34	48	---	19	10	7	24	19	0	29	214
5	63	79	---	26	27	26	24	0	0	17	302
6	49	52	---	10	19	18	3	4	7	9	197
7	114	111	---	9	30	49	27	12	0	26	433
8	55	57	---	13	17	20	25	5	11	7	239
9	53	45	---	27	13	23	28	13	6	6	237
10	78	18	---	8	16	24	40	8	8	2	211
11	147	23	---	26	13	19	44	6	5	13	308
12	35	21	---	(b)	20	29	35	24	12	15	191
13	35	12	---	(b)	16	27	27	9	12	0	138
14	33	7	---	(b)	21	26	24	0	0	0	111
15	44	2	---	(b)	24	29	47	0	0	0	196

[a]Instrument malfunction.
[b]Sensing crystal saturated with sample.

TABLE 5 - PARTICLE NUMBER DENSITY (PERCENTAGE OF TOTAL) AS

FUNCTION OF DIAMETER (FSSP DATA)

(a) Instrument range, 30-μm dıameter

Pass	Number densıty, percent, for dıameter, μm, of -														
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
1	50.0	40.8	5.5	0.09	0 4	0 05	0.3	0.3	0.2	0.4	0.4	0 3	0.5	0 5	0 3
2	26.4	26.9	24.6	17 6	2 0	4	3	.2	.2	.3	.2	.2	.2	2	2

(b) Instrument range, 15-μm dıameter

Pass	Number densıty, percent, for dıameter, μm, of -														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3	9.7	12.6	12 1	12 7	13 0	10 7	6 7	6 30	4.1	1 9	0.8	0.90	0.30	0 20	0.20
4	6.3	9.6	12 0	15 2	15 0	13 4	10.2	8.80	5.6	2 2	.9	30	30	.10	.07
5	7 1	10 8	14.3	15 7	15.4	14 7	9.2	7.80	3 2	1 0	4	.20	.10	.08	.07
6	16.0	17.0	17 0	17 9	15.5	10 8	4 3	1.30	5	2	1	10	10	.05	09
7	20.2	19.0	15.6	14 5	12 8	9 9	4.6	1.70	.7	.3	2	10	.20	.10	.10
8	19.6	19 2	18 1	17 2	14 1	7 2	2 6	90	4	.2	1	.07	09	10	08
9	21 4	20.9	19 2	17.4	11 7	5 5	2 0	.80	3	.2	.1	.10	10	07	10
10	25 4	20.3	17 9	16 7	11 6	4 6	1.7	70	3	.2	.1	.10	10	.06	10
11	21 1	20.5	18 6	17 1	12 9	5 6	2 3	90	4	2	1	.09	06	.08	08
12	28 4	22.4	17 3	14.3	9 2	4 5	1 8	.80	.4	2	2	10	10	.10	10
13	29.2	23.4	17 2	14 4	8 4	3 7	1.7	.05	.4	3	.2	.20	.20	20	.20
14	36 4	23.7	11 8	8 7	5 7	2 9	1.8	1.20	1.3	1 3	1.0	.07	1 00	1.10	1 10
15	40.0	25.3	11 3	8.2	5 0	2 7	1 4	90	.7	8	9	.90	.60	.90	90

TABLE 5.- Concluded

(c) Instrument range, 7.5-μm diameter

Pass	Number density, percent, for diameter, μm, of -														
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5
16	14.6	26.6	24.5	12.5	6.2	4.9	3.5	2.0	1.5	1.2	0.6	0.6	0.6	0.4	0.3
17	17.7	22.7	17.0	9.8	7.6	6.9	5.8	4.0	2.3	1.5	1.3	1.1	1.0	9	6
18	29.9	29.7	16.7	5.3	2.6	2.5	1.9	1.6	1.6	1.4	1.7	1.3	1.5	1.3	1.3
19	17.4	28.4	23.8	10.4	5.2	4.1	2.5	1.9	1.5	9	1.0	.9	6	6	.8
20	11.3	9.1	6.6	5.5	7.5	6.2	6.0	5.3	5.6	7.2	5.2	6.9	6.3	4.7	6.7
21	44.8	29.4	10.7	3.8	1.9	2.2	1.5	1.0	.7	.4	.4	.3	3	3	1.8
22	39.3	30.8	14.5	4.7	2.6	2.1	1.2	.8	.5	.3	.2	.2	.2	.2	.2
23	43.6	27.3	9.1	4.2	3.8	3.4	2.2	1.4	1.1	.6	8	.7	6	.6	6
24	43.0	27.7	9.0	4.4	3.9	3.6	2.6	1.1	.7	.9	.7	5	.7	.6	.7
25	33.0	24.3	8.5	5.8	5.5	4.6	4.0	2.8	1.9	1.5	1.9	1.5	1.5	1.6	1.6
26	36.7	26.0	9.3	5.3	5.5	4.6	3.2	2.3	1.3	8	1.1	1.0	8	1.0	1.2
27	37.1	26.2	9.4	5.3	5.3	4.3	3.5	2.1	1.2	8	1.1	.9	.9	1.0	.8
28	29.8	21.7	8.7	6.0	5.4	5.4	4.3	3.1	2.3	2.1	2.1	2.3	1.9	2.3	2.3
29	28.6	18.7	6.8	7.2	5.1	4.0	4.8	3.6	2.9	2.9	3.9	2.1	2.6	4.1	2.9
30	36.4	24.3	9.3	9.3	6.9	5.3	5.2	3.8	4.2	4.7	4.5	4.0	4.8	3.6	4.0
31	24.1	15.1	9.5	3.7	5.3	6.3	4.1	3.9	4.1	3.3	4.6	5.2	2.8	3.7	4.5
32	33.3	21.6	7.4	5.5	5.5	4.6	3.2	2.5	2.4	2.4	2.4	2.3	2.4	2.4	2.2
33	33.1	20.0	6.5	6.5	4.9	3.2	2.6	3.0	2.8	2.4	2.6	2.2	3.0	2.8	2.4
34	37.6	22.7	7.8	6.5	6.2	4.3	2.6	1.6	1.8	1.5	1.4	1.6	1.6	1.4	1.4
35	33.2	20.0	7.4	6.9	6.0	4.3	3.1	2.9	2.0	2.2	2.9	2.3	2.2	2.3	2.3
36	34.9	22.6	8.0	5.9	5.3	4.6	2.9	2.7	2.1	1.4	1.9	2.1	1.9	2.1	1.8
37	34.0	20.5	7.8	6.5	6.5	4.9	2.5	2.3	2.3	2.4	2.5	2.1	1.6	1.8	2.6
38	37.4	24.7	8.2	6.0	5.8	4.1	2.2	1.7	1.5	1.3	1.3	1.5	1.6	1.5	1.1
39	34.9	21.5	7.9	6.7	4.5	4.1	3.4	2.2	2.4	2.6	1.7	1.5	2.4	2.4	1.5
40	31.8	19.1	6.8	7.1	5.4	3.3	3.8	2.6	2.4	3.3	3.1	2.6	3.3	3.1	2.6
41	31.6	18.2	7.3	6.6	5.3	3.6	3.6	2.7	3.2	3.2	3.2	2.9	2.9	3.2	2.7
42	29.0	18.0	8.5	7.2	5.7	4.1	3.3	3.3	2.1	3.3	3.1	2.6	3.3	3.1	3.1
43	25.7	13.6	5.7	6.8	6.1	4.3	5.0	3.9	4.6	3.6	3.9	4.3	4.3	3.9	4.3
44	33.7	20.9	8.1	7.0	6.3	4.0	3.0	2.3	2.3	2.1	2.1	2.1	2.1	1.8	2.1
45	29.4	17.2	8.0	6.5	5.7	4.2	4.2	2.7	3.5	3.7	2.7	2.7	3.2	3.2	2.7
46	35.6	21.6	7.8	7.4	6.1	3.8	2.6	2.0	1.8	2.0	1.5	2.0	2.0	1.7	2.0
47	29.4	16.8	8.1	7.3	5.7	5.5	3.1	2.6	3.8	2.4	1.7	3.6	2.6	2.8	3.3
48	36.7	20.6	9.0	7.8	5.3	3.3	2.6	2.0	1.7	2.2	1.7	1.6	2.0	1.7	1.9
49	42.6	19.8	8.9	6.6	5.2	2.3	1.9	1.7	1.7	1.9	1.3	1.6	2.3	1.1	1.2
50	50.9	18.5	6.7	5.3	3.7	2.9	1.5	1.3	1.5	1.1	1.4	1.4	1.2	1.3	1.4

TABLE 6.- AIRBORNE DATA SAMPLING PASS 1

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
20	0.6	2	15	50
22	.6	2	47	49
24	.6	2	13	50
26	3.6	2	81	61
28	3.6	2	92	486
30	1.9	2	90	489
32	4.2	2	-4	349
34	25.6	17	35	640
36	5.5	29	29	988
38	2.8	18	16	543
40	1.9	27	203	277
42	1.6	40	507	156
44	1.4	20	384	109
46	1.3	3	546	85
48	1.2	2	945	63
50	1.1	2	476	71
52	1.1	2	126	72
54	1.0	1	45	71
56	1.0	1	41	75
58	1.0	1	74	75
60	1.0	1	37	80

TABLE 7.- AIRBORNE DATA SAMPLING PASS 2

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.8	4	90	34
2	.8	4	74	31
4	.6	3	34	31
6	1.5	3	51	34
8	1.0	2	63	68
10	20.0	2	35	117
12	20.0	2	60	293
14	12.2	7	33	366
16	5.7	4	-8	256
18	4.3	21	5	134
20	3.5	28	83	77
22	2.8	19	210	52
24	2.2	8	762	41
26	2.0	3	972	37
28	1.9	2	753	35
30	1.7	2	258	34
32	1.6	2	72	35
34	1.5	2	87	34
36	1.3	2	45	34
38	1.3	2	41	34
40	1.3	2	-62	34

TABLE 8.- AIRBORNE DATA SAMPLING PASS 3

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.8	2	74	34
2	.8	2	2	29
4	.8	2	71	28
6	.8	2	-6	28
8	.7	2	15	28
10	.7	2	28	26
12	1.2	2	46	28
14	3.4	2	126	149
16	5.2	2	64	191
18	2.9	2	92	170
20	7.5	3	62	117
22	7.8	6	32	158
24	4.7	6	-33	152
26	3.0	4	102	103
28	2.3	5	180	65
30	2.1	9	206	46
32	1.9	5	209	41
34	1.7	3	295	33
36	1.7	3	371	30
38	1.5	2	302	30
40	1.5	1	173	31
42	1.3	1	40	30
44	1.4	1	50	28
46	1.3	1	63	26
48	1.3	1	29	30
50	1.3	1	33	29

TABLE 9.- AIRBORNE DATA SAMPLING PASS 4

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.7	2	7	26
2	.7	1	37	29
4	.8	1	-15	29
6	.7	1	124	24
8	.8	1	96	26
10	.6	1	77	26
12	2.9	1	85	55
14	5.1	1	.4	147
16	4.9	-2	56	174
18	3.2	2	-11	178
20	6.9	3	78	129
22	10.4	5	129	171
24	10.0	4	52	200
26	21.9	3	122	195
28	22.1	4	192	225
30	17.2	6	155	210
32	7.6	13	206	160
34	5.1	21	211	92
36	4.0	17	276	59
38	3.4	12	358	42
40	3.0	4	649	37
42	2.7	2	735	34
44	2.5	1	606	37
46	2.3	1	293	33
48	2.1	0	151	31
50	2.0	0	76	31

TABLE 10.- AIRBORNE DATA SAMPLING PASS 5

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.6	1	47	22
2	.6	1	6	22
4	.6	1	57	22
6	.7	1	35	21
8	1.0	1	66	41
10	4.5	1	143	61
12	7.1	1	63	116
14	9.6	1	26	156
16	12.1	1	30	182
18	11.7	3	26	186
20	12.6	6	79	200
22	15.0	6	73	225
24	15.8	8	208	236
26	14.4	7	243	226
28	13.8	5	388	217
30	13.6	6	417	223
32	9.7	7	395	218
34	6.4	7	303	187
36	7.9	5	364	169
38	4.7	5	437	131
40	3.7	4	520	74
42	3.1	2	464	55
44	2.5	2	469	54
46	2.4	2	377	57
48	2.3	1	221	35
50	2.1	1	178	35
52	1.9	1	140	35
54	1.7	1	85	35
56	1.7	1	5	35
58	1.7	1	-16	35
60	1.5	1	88	35

TABLE 11.- AIRBORNE DATA SAMPLING PASS 6

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	1.0	3	-24	10
2	1.0	3	3	9
4	1.0	3	28	10
6	1.0	2	123	10
8	.9	2	106	10
10	1.4	2	124	21
12	1.5	2	125	51
14	1.9	2	110	53
16	4.7	2	63	92
18	7.3	2	108	126
20	7.2	2	52	149
22	7.0	2	53	155
24	5.7	4	106	154
26	4.4	5	80	147
28	4.9	5	138	140
30	7.8	4	156	136
32	9.1	3	221	133
34	8.8	2	252	114
36	7.3	3	262	96
38	4.7	4	222	71
40	4.3	6	240	53
42	2.7	6	256	42
44	2.1	4	269	29
46	1.8	2	324	22
48	1.7	2	307	18
50	1.7	1	198	16
52	1.5	1	144	17
54	1.4	1	22	18
56	1.3	1	66	18
58	1.2	1	30	17
60	1.2	1	51	18

TABLE 12.- AIRBORNE DATA SAMPLING PASS 7

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
10	0 5	1	69	8
12	6	1	75	10
14	7	0	57	19
16	.8	0	62	26
18	7	0	35	22
20	.8	1	50	17
22	1 2	1	40	27
24	4.7	1	51	58
26	4 9	1	54	94
28	3 9	2	65	105
30	4.7	2	85	106
32	9.7	4	84	117
34	11 3	5	58	135
36	10 5	5	55	141
38	10.9	5	102	142
40	11 5	9	149	153
42	10.8	9	175	163
44	10.1	8	189	160
46	8.6	6	237	148
48	7.4	6	284	139
50	6.7	6	331	147
52	5 8	5	336	138
54	6 3	3	386	132
56	5 4	6	388	131
58	4 1	3	378	94
60	3 2	5	338	54
62	2 9	2	341	34
64	2 4	2	326	24
66	2.2	0	289	22
68	2.0	0	271	21
70	1 9	0	252	20
72	1.9	0	210	19
74	1 8	0	167	18
76	1 7	0	125	18
78	1 6	0	123	19
80	1 7	0	112	18
82	1 7	0	84	18
84	1.7	0	78	16
86	1 6	0	73	19
88	1 6	0	64	17
90	1 6	0	66	17

TABLE 13.- AIRBORNE DATA SAMPLING PASS 8

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.4	2	44	8
2	.4	2	43	10
4	.4	2	49	11
6	.3	2	29	11
8	.4	2	37	11
10	.3	2	40	10
12	.4	2	43	14
14	.5	2	50	27
16	1.3	2	43	59
18	2.2	1	46	93
20	3.0	1	38	112
22	4.0	2	47	119
24	4.8	3	46	133
26	5.7	4	34	137
28	5.7	4	43	139
30	7.6	4	76	147
32	9.2	4	100	158
34	8.8	4	115	165
36	10.5	4	135	168
38	11.0	5	157	168
40	10.8	6	155	163
42	12.2	7	168	164
44	9.6	8	172	164
46	8.8	7	210	169
48	6.8	12	232	141
50	5.5	8	258	89
52	4.6	6	263	64
54	3.8	9	317	44
56	3.3	2	333	30
58	2.9	0	361	25
60	2.6	0	337	23
62	2.5	0	293	22
64	2.4	0	238	23
66	2.1	0	188	21
68	1.9	0	157	20
70	1.8	0	124	20

TABLE 14.- AIRBORNE DATA SAMPLING PASS 9

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0 5	3	41	10
2	5	3	32	10
4	6	3	47	8
6	.7	3	49	11
8	6	3	46	13
10	.6	3	58	12
12	1.3	3	41	28
14	2.8	3	32	67
16	3 6	3	40	94
18	5.1	3	53	117
20	6.1	4	37	135
22	6.1	8	14	145
24	7.6	10	49	151
26	9 7	13	79	154
28	8 3	9	107	159
30	8 0	11	134	159
32	8 9	12	187	156
34	8 5	13	206	159
36	9 8	11	208	157
38	10 0	9	216	162
40	10 3	10	257	162
42	9 4	9	278	159
44	9 3	10	292	155
46	7 3	10	292	146
48	6.7	8	302	134
50	5.7	9	319	118
52	4 9	8	325	75
54	4.2	5	343	46
56	3 9	3	336	32
58	3.7	2	342	25
60	3 3	1	288	24
62	3 1	1	237	24
64	2.9	1	215	22
66	2.6	1	171	22
68	2 4	1	113	21
70	2 3	1	118	22
72	2 1	1	92	21
74	2.0	1	93	22
76	1 9	0	93	21
78	1.8	0	82	21
80	1.7	1	70	22

TABLE 15.- AIRBORNE DATA SAMPLING PASS 10

Reference time, sec	HCl concentration, ppm	Cl_2 concentration, ppb	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.6	2	46	11
2	.6	2	60	10
4	.6	2	60	17
6	.6	2	45	23
8	.7	2	47	27
10	1.0	2	47	31
12	1.2	2	36	53
14	1.7	2	29	68
16	2.5	2	38	83
18	3.4	2	56	105
20	4.1	3	40	114
22	4.3	4	19	117
24	6.4	4	50	127
26	7.4	4	73	143
28	6.8	5	76	141
30	8.4	4	96	121
32	7.3	7	102	123
34	6.6	10	145	99
36	6.2	6	149	83
38	4.8	7	158	67
40	4.2	6	176	50
42	3.7	5	195	43
44	3.5	4	216	37
46	3.4	2	227	27
48	3.1	2	232	20
50	2.9	5	239	19
52	2.7	0	189	17
54	2.5	0	151	17
56	2.3	0	119	16
58	2.1	0	108	16
60	2.0	0	89	14

TABLE 16 - AIRBORNE DATA SAMPLING PASS 11

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.7	54	8
2	7	53	8
4	6	44	9
6	.7	39	11
8	1 0	47	22
10	1.4	58	38
12	2 1	42	57
14	2.5	41	72
16	2 7	27	85
18	3 0	24	77
20	3.5	23	76
22	6.1	21	86
24	7.5	29	111
26	8.6	48	129
28	8.9	80	137
30	9 8	106	143
32	10.0	135	151
34	10.6	120	159
36	10.9	153	167
38	10.4	185	169
40	11.2	236	168
42	11.0	287	163
44	10 5	305	161
46	9.4	318	159
48	8.6	350	159
50	7.4	383	132
52	6.4	378	83
54	5.4	369	61
56	5.0	367	43
58	4.5	367	30
60	4.0	374	23
62	3.5	335	23
64	3.3	295	22
66	3.2	226	21
68	3.1	144	21
70	3.0	119	21
72	2.9	113	21
74	2.8	84	19
76	2.7	64	20
78	2.6	101	21
80	2.6	155	21

TABLE 17.- AIRBORNE DATA SAMPLING PASS 12

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.8	64	12
2	.7	63	11
4	.7	35	10
6	.7	38	9
8	.7	33	11
10	.7	6	14
12	.9	9	26
14	1.4	9	58
16	1.8	14	84
18	2.7	32	106
20	3.4	54	120
22	3.4	44	130
24	4.1	41	140
26	5.0	49	141
28	7.8	75	147
30	8.7	78	157
32	8.9	68	157
34	8.8	104	150
36	8.1	136	125
38	7.1	136	100
40	6.9	157	80
42	6.9	193	80
44	5.7	246	84
46	5.1	247	55
48	4.4	264	34
50	3.8	301	24
52	3.2	286	20
54	3.0	278	19
56	2.7	271	18
58	2.5	235	18
60	2.4	159	18
62	2.4	155	17
64	2.2	138	17
66	2.2	126	18
68	2.1	100	16
70	2.1	75	17
72	2.0	63	17
74	2.0	51	17
76	1.9	33	17
78	1.7	26	15
80	1.6	49	17

TABLE 18.- AIRBORNE DATA SAMPLING PASS 13

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
20	0.7	50	8
22	.9	50	11
24	1.7	34	24
26	2.0	15	46
28	2.0	16	53
30	2.3	7	48
32	3.8	3	66
34	4.8	28	99
36	6.1	42	119
38	6.9	81	130
40	6.3	117	125
42	7.3	125	109
44	8.6	98	122
46	9.0	113	141
48	9.5	137	149
50	10.1	184	155
52	10.4	225	165
54	9.5	238	166
56	8.9	266	159
58	9.3	284	150
60	7.8	317	147
62	6.7	344	108
64	5.7	352	63
66	5.3	355	37
68	4.7	355	26
70	4.2	355	21
72	3.9	342	20
74	3.7	310	18
76	3.5	257	18
78	3.4	202	19
80	3.3	183	20
82	3.1	142	18
84	3.1	104	19
86	3.0	77	20
88	3.0	62	17
90	3.0	60	19

TABLE 19.- AIRBORNE DATA SAMPLING PASS 14

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
10	0.8	58	9
12	.7	55	10
14	.7	72	11
16	.7	90	10
18	.7	65	11
20	1.1	52	43
22	1.6	41	77
24	1.9	75	103
26	3.0	58	114
28	3.4	63	129
30	4.0	64	137
32	6.1	72	143
34	6.6	49	153
36	7.8	67	159
38	7.6	98	158
40	8.0	119	159
42	7.6	127	155
44	6.1	131	139
46	5.3	140	95
48	4.9	202	58
50	4.5	248	37
52	4.0	245	32
54	3.7	283	24
56	3.4	305	20
58	3.1	271	18
60	3.1	228	16
62	3.0	187	16
64	2.8	135	16
66	2.7	113	16
68	2.5	102	17
70	2.5	94	17

TABLE 20.- AIRBORNE DATA SAMPLING PASS 15

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.7	31	10
2	.7	28	11
4	.7	27	10
6	.7	31	12
8	.8	33	20
10	.9	56	43
12	1.0	59	50
14	1.0	31	51
16	1.4	6	45
18	1.9	-4	57
20	2.5	19	78
22	3.6	18	101
24	4.5	58	117
26	5.8	49	129
28	6.3	35	143
30	7.0	48	145
32	8.4	70	150
34	8.4	83	149
36	8.9	110	154
38	9.1	142	164
40	9.4	190	164
42	10.1	206	169
44	9.5	239	171
46	10.0	254	174
48	8.2	293	172
50	6.8	298	135
52	6.2	300	90
54	5.8	304	63
56	5.4	296	40
58	5.0	301	29
60	4.8	280	22
62	4.5	287	20
64	4.1	230	19
66	3.8	176	20
68	3.5	134	20
70	3.0	120	21

TABLE 21.- AIRBORNE DATA SAMPLING PASS 16

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.9	42	11
2	.9	49	11
4	8	50	11
6	.9	55	11
8	.8	71	13
10	.9	44	15
12	1.0	39	28
14	1.1	27	62
16	1 4	17	69
18	1 9	-12	95
20	3.0	-12	116
22	3 6	1	135
24	4 1	26	144
26	5.5	31	144
28	6 5	53	152
30	7.0	62	157
32	8.2	94	155
34	8.1	108	152
36	7.8	117	142
38	6.9	127	120
40	7.1	141	99
42	6.5	189	88
44	6.0	212	86
46	5.6	249	78
48	4.8	250	65
50	4.1	259	44
52	4.0	245	29
54	3 8	210	23
56	3 9	219	20
58	3.8	213	19
60	3.6	200	18
62	3.3	173	17
64	3.0	132	17
66	2.8	109	17
68	2.7	80	16
70	2.6	69	16
72	2.3	66	16
74	2.3	48	18
76	2.3	43	16
78	2.3	41	17
80	2.3	53	16

TABLE 22.- AIRBORNE DATA SAMPLING PASS 17

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.6	55	10
2	.6	54	11
4	1.2	45	24
6	1.6	61	45
8	1.7	36	56
10	1.7	16	59
12	2.0	13	62
14	2.5	12	67
16	3.1	-5	76
18	3.1	40	93
20	4.4	63	100
22	5.3	72	113
24	5.7	94	116
26	6.3	105	118
28	5.6	101	129
30	7.1	116	132
32	8.1	125	139
34	8.0	137	142
36	5.6	173	124
38	4.8	182	81
40	4.4	191	48
42	4.0	215	29
44	3.6	249	23
46	3.5	263	18
48	3.2	260	17
50	2.9	236	16
52	2.8	207	15
54	2.6	111	14
56	2.5	83	14
58	2.3	75	16
60	2.1	72	14

TABLE 23.- AIRBORNE DATA SAMPLING PASS 18

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
10	0.6	5	11
12	.6	42	11
14	.6	30	14
16	.7	14	22
18	.7	28	27
20	.6	6	22
22	.7	17	23
24	1.3	24	56
26	1.5	44	90
28	1.7	72	91
30	2.1	63	87
32	2.4	47	92
34	2.5	31	103
36	2.7	48	108
38	3.1	65	105
40	3.4	94	106
42	3.3	97	100
44	3.3	137	92
46	3.1	135	86
48	2.9	141	71
50	2.7	123	64
52	2.6	133	60
54	2.4	140	56
56	2.2	136	40
58	2.0	128	26
60	1.8	117	20
62	1.7	91	19
64	1.6	80	17
66	1.5	100	16
68	1.4	72	15
70	1.3	69	15

TABLE 24.- AIRBORNE DATA SAMPLING PASS 19

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0 6	6	9
2	6	1	9
4	.6	-2	11
6	.6	21	10
8	5	39	11
10	.6	15	11
12	.7	-6	17
14	1.0	23	31
16	1.1	31	48
18	1 4	33	62
20	1.8	23	76
22	2.6	31	91
24	3.0	13	105
26	4.1	46	118
28	4 3	37	129
30	4 1	31	121
32	5.1	57	108
34	5.3	72	119
36	5.5	70	128
38	6.6	101	132
40	6.4	124	137
42	6.8	163	131
44	6 2	161	129
46	5.9	183	130
48	5.3	202	121
50	4 7	223	84
52	4 1	221	48
54	3.7	227	31
56	3 3	230	25
58	3.1	194	25
60	2.9	216	28
62	2.6	179	29
64	2.4	155	26
66	2 3	127	21
68	2.2	89	20
70	2.1	64	21
72	2.1	55	18
74	2.1	52	19
76	2.2	41	18
78	2.3	16	17
80	2.3	22	15

TABLE 25.- AIRBORNE DATA SAMPLING PASS 20

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.7	51	10
2	.7	47	10
4	.7	38	12
6	.7	34	10
8	.7	19	22
10	.7	26	30
12	.7	41	34
14	.7	33	31
16	.8	47	30
18	.9	52	35
20	1.2	69	61
22	1.7	56	92
24	1.6	62	114
26	1.6	45	93
28	1.6	75	72
30	1.7	72	50
32	1.6	42	37
34	1.5	80	25
36	1.4	109	16
38	1.4	114	13
40	1.3	113	12
42	1.3	114	11
44	1.2	110	12
46	1.1	108	12
48	1.0	104	11
50	1.1	99	12
52	1.1	81	11
54	1.0	47	11
56	1.0	47	12
58	1.0	30	11
60	1.0	43	11

TABLE 26.- AIRBORNE DATA SAMPLING PASS 21

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.4	32	9
2	4	49	9
4	.4	43	11
6	.4	56	18
8	.5	41	39
10	.8	23	67
12	1.2	28	120
14	1 4	40	157
16	1.6	23	158
18	1.9	34	157
20	2 1	42	162
22	2.5	57	173
24	3 0	82	182
26	3.2	136	188
28	3 6	125	196
30	3.9	121	200
32	4.1	97	196
34	4.5	116	199
36	4 9	157	201
38	5.1	176	201
40	5.2	192	197
42	4.9	221	185
44	5 0	254	182
46	5.2	228	182
48	5.0	248	182
50	5.0	232	177
52	4.8	254	178
54	3.8	223	169
56	3.3	215	121
58	2.8	229	82
60	2 4	193	54
62	2 2	192	40
64	2.0	182	32
66	1 9	166	31
68	1.7	166	30
70	1.6	132	29
72	1.6	105	27
74	1.5	65	27
76	1 5	65	27
78	1.4	67	26
80	1 4	43	27

TABLE 27 - AIRBORNE DATA SAMPLING PASS 22

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0 6	56	10
2	6	35	11
4	.6	34	12
6	6	49	13
8	6	38	15
10	6	32	19
12	6	39	28
14	6	37	38
16	1 1	16	44
18	1.4	40	105
20	1 7	19	145
22	2.0	27	161
24	2 3	23	176
26	2.9	20	185
28	3 2	45	195
30	3 5	42	200
32	3 9	29	196
34	4 2	61	190
36	4 6	75	196
38	4 5	93	194
40	4 8	121	181
42	4 9	119	172
44	5 0	154	162
46	5 2	170	160
48	5.8	174	160
50	5 3	155	168
52	4 9	174	167
54	4 6	184	153
56	4 6	184	136
58	4 4	195	126
60	4.4	198	124
62	4 7	180	135
64	3 8	211	134
66	3 2	240	92
68	2 9	221	59
70	2 6	210	40
72	2 5	203	34
74	2 3	211	31
76	2 1	228	28
78	1 9	218	28
80	1 7	177	29
82	1 6	132	28
84	1.5	89	28
86	1 4	59	27
88	1 4	40	25
90	1 4	55	24

TABLE 28 - AIRBORNE DATA SAMPLING PASS 23

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0 6	25	11
2	6	51	11
4	6	32	11
6	6	39	10
8	7	56	26
10	8	47	51
12	7	47	61
14	7	36	43
16	7	37	28
18	7	31	25
20	9	40	33
22	1 0	36	58
24	1 3	38	83
26	1 5	34	97
28	1 7	55	104
30	1 7	62	98
32	2 0	63	95
34	2 3	33	117
36	2 7	48	135
38	2 8	60	150
40	2 9	86	158
42	2 9	73	154
44	3 1	109	142
46	2 6	95	132
48	3 0	118	123
50	3 1	142	145
52	4 3	142	163
54	4 3	118	170
56	4 6	137	175
58	4 6	138	172
60	4 6	142	171
62	4 1	140	171
64	4 0	163	163
66	4 1	177	162
68	3 9	170	166
70	3 9	167	154
72	3.5	212	146
74	3 1	231	125
76	3 3	229	119
78	3 0	203	125
80	2 8	187	94
82	2 6	167	72
84	2 4	162	66
86	2 0	138	49
88	1 9	102	42
90	1 8	104	35

TABLE 29 - AIRBORNE DATA SAMPLING PASS 24

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0 5	50	12
2	6	49	10
4	5	65	10
6	5	50	11
8	.5	59	11
10	5	69	13
12	5	58	16
14	6	23	23
16	9	45	54
18	1 4	41	103
20	1 9	48	141
22	2 1	63	169
24	2 8	59	185
26	3 0	49	199
28	3.2	36	201
30	3 5	56	200
32	3 2	78	202
34	3 2	63	190
36	3 4	84	176
38	3 9	110	176
40	3 7	123	181
42	3 5	167	164
44	3 5	165	150
46	3 7	164	155
48	4 0	157	164
50	4 0	163	168
52	4 0	187	162
54	3 6	192	149
56	3 4	190	132
58	3 4	172	112
60	3 7	199	116
62	3 7	216	138
64	3 0	233	121
66	2 7	221	75
68	2.5	219	52
70	2 3	209	38
72	2 1	193	33
74	2 0	193	29
76	1 9	210	27
78	1 7	163	26
80	1.7	135	24
82	1 5	127	25
84	1 4	107	23
86	1 3	81	23
88	1 3	75	22
90	1.2	61	23

TABLE 30.- AIRBORNE DATA SAMPLING PASS 25

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0.2	46	8
2	.2	-3	9
4	.2	24	10
6	.2	24	9
8	.2	16	10
10	.2	-17	12
12	.2	1	15
14	.2	-8	22
16	.2	-5	27
18	.3	-18	31
20	.3	1	31
22	.3	25	31
24	.3	39	28
26	.3	20	28
28	.3	47	33
30	.4	-4	32
32	.4	-13	39
34	.5	11	44
36	.5	18	43
38	.6	18	51
40	.6	55	56
42	.7	35	59
44	.8	28	66
46	.9	31	68
48	1.1	37	76

TABLE 30.- Concluded

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
50	1.3	46	91
52	1.7	56	103
54	1.9	44	127
56	1.7	45	139
58	1.8	44	122
60	2.0	40	118
62	1.9	32	120
64	2.1	73	114
66	2.0	91	117
68	2.0	113	103
70	2.1	128	98
72	2.2	127	108
74	2.5	130	109
76	2.5	139	122
78	1.9	121	105
80	1.7	131	69
82	1.5	142	45
84	1.3	157	32
86	1.2	153	24
88	1.2	165	18
90	1.1	173	18
92	1.0	154	17
94	.9	123	17
96	.9	119	16
98	.8	125	16
100	.8	83	16

TABLE 31 - AIRBORNE DATA SAMPLING PASS 26

Reference time, sec	HCl concentration, ppm	NO_x concentration, ppb	Particle concentration (nephelometer), $\mu g/m^3$
0	0 3	32	10
2	3	31	12
4	3	21	11
6	3	21	12
8	4	28	20
10	.4	30	30
12	.4	37	34
14	6	49	45
16	6	41	61
18	8	41	84
20	1.2	48	95
22	1 7	43	122
24	2.4	41	154
26	2 7	44	180
28	3.2	51	196
30	3 5	25	207
32	3 6	37	211
34	3 5	37	210
36	3 6	38	201
38	3 4	55	186
40	3 4	93	174
42	3 7	130	168
44	3 8	158	173
46	3 9	165	173
48	4.2	171	174
50	4 3	187	180
52	3 7	177	179
54	3 5	184	158
56	3 5	178	140
58	3 5	192	121
60	3 5	196	125
62	4 0	190	130
64	3.8	189	149
66	3 0	213	128
68	2 7	198	85
70	2.4	153	62
72	2 4	124	62
74	2 0	100	61
76	1 8	122	44
78	1 6	103	33
80	1 5	126	28
82	1 4	78	29
84	1 4	60	27
86	1 4	27	27
88	1 4	34	27
90	1.3	11	25

TABLE 32 - AIRBORNE DATA SAMPLING PASS 27

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0 7	14
2	7	14
4	7	19
6	9	26
8	9	36
10	9	35
12	8	31
14	8	29
16	1 0	43
18	1 0	64
20	1 1	68
22	1 4	69
24	1 5	71
26	2 0	80
28	2 5	114
30	2 7	136
32	3 0	145
34	3 2	152
36	3 4	152
38	3 1	151
40	3 1	141
42	3 2	140
44	3 6	144
46	3 9	159
48	4 0	170
50	4 1	176
52	4 4	178
54	4 5	181
56	4 5	183
58	4 6	181
60	4 5	179
62	3 9	179
64	3 7	162
66	3 6	131
68	3 2	130
70	3 1	119
72	2 8	105
74	2 4	81
76	2 2	56
78	2 0	41
80	2 0	37
82	2 0	47
84	1 9	57
86	1 6	54
88	1 5	45
90	1 4	42
92	1 3	34
94	1 3	35
96	1 2	34
98	1 2	32
100	1 1	27

TABLE 33.- AIRBORNE DATA SAMPLING PASS 28

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0 5	12
2	.5	12
4	.4	12
6	5	14
8	.5	19
10	.6	22
12	.7	58
14	1.4	94
16	1.6	124
18	2.3	147
20	2.8	167
22	2.6	172
24	2.4	155
26	2.4	131
28	2 4	124
30	2.2	121
32	2.6	111
34	2.5	121
36	2.7	118
38	2 9	124
40	3.0	135
42	2.9	138
44	2.8	128
46	2 6	110
48	2.3	93
50	2.2	77
52	2.1	67
54	1.8	55
56	1.7	41
58	1.6	29
60	1 4	24
62	1.4	22
64	1.2	23
66	1.1	21
68	1.1	21
70	1 1	17
72	1.0	17
74	1.0	18
76	1.0	18
78	9	17
80	.9	17

TABLE 34.- AIRBORNE DATA SAMPLING PASS 29

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
30	0.1	11
32	.1	11
34	.1	10
36	.1	27
38	.2	79
40	.3	104
42	.4	128
44	.5	136
46	.6	138
48	.6	139
50	.6	119
52	.6	101
54	.7	102
56	.8	109
58	.7	109
60	.7	94
62	.7	90
64	.9	97
66	.9	105
68	1.0	120
70	1.2	118
72	1.3	139
74	1.0	133
76	.7	88
78	.6	56
80	.5	41
82	.5	35
84	.7	67
86	.5	78
88	.4	51
90	.4	34

TABLE 35.- AIRBORNE DATA SAMPLING PASS 30

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.2	9
2	.2	9
4	.2	10
6	.2	11
8	.2	12
10	.2	12
12	.1	15
14	.2	49
16	.2	88
18	.5	115
20	.6	146
22	.8	155
24	.9	146
26	1.0	145
28	1.3	157
30	1.3	163
32	1.1	153
34	.9	121
36	.8	84
38	.7	65
40	.6	47

TABLE 36.- AIRBORNE DATA SAMPLING PASS 31

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
10	0.2	11
12	.1	12
14	.2	17
16	.2	48
18	.2	68
20	.4	93
22	.6	118
24	.9	148
26	1.3	167
28	1.6	180
30	1.6	173
32	1.9	173
34	1.9	178
36	1.6	159
38	1.6	139
40	1.5	125
42	1.4	111
44	1.2	85
46	1.0	68
48	.8	50
50	.7	37
52	.7	28
54	.6	23
56	.6	20
58	.6	19
60	.5	18

TABLE 37.- AIRBORNE DATA SAMPLING PASS 32

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.3	15
2	.3	14
4	.3	16
6	.3	18
8	.5	33
10	.7	62
12	.9	97
14	.9	91
16	1 2	100
18	1.3	109
20	1.5	123
22	1.4	142
24	1 1	131
26	.9	80
28	.8	50
30	.7	31
32	.6	23
34	.6	28
36	.6	30
38	.6	39
40	5	29
42	.5	23
44	5	18
46	.5	17
48	.5	15
50	4	18
52	.5	31
54	.7	72
56	1.0	118
58	1.3	139
60	1.5	147
62	1 6	159
64	1.7	152
66	1.9	166
68	1.9	159
70	2.1	158
72	2.3	176
74	2.4	189
76	2.2	175
78	2.0	146

TABLE 37.- Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
80	1.9	129
82	2.2	138
84	2.4	159
86	2.2	152
88	2.3	148
90	2.3	150
92	2.6	166
94	2.5	176
96	2.5	165
98	2.7	167
100	2.6	170
102	2.6	162
104	2.5	162
106	2.4	159
108	2.6	157
110	2.7	162
112	2.6	159
114	2.5	156
116	2.8	155
118	2.8	161
120	2.9	166
122	2.7	170
124	2.9	169
126	2.8	173
128	2.9	173
130	2.3	162
132	1.8	110
134	1.6	75
136	1.4	58
138	1.3	55
140	1.3	50
142	1.2	44
144	1.1	38
146	1.0	34
148	1.0	31
150	.9	30

TABLE 38.- AIRBORNE DATA SAMPLING PASS 33

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.5	58
2	.7	92
4	.9	121
6	1.4	142
8	1.7	165
10	2.0	178
12	2.1	176
14	2.1	168
16	2.1	144
18	2.1	148
20	1.8	133
22	1.7	100
24	1.8	113
26	2.0	111
28	2.0	102
30	1.9	97
32	1.8	90
34	1.6	79
36	1.4	59
38	1.3	47
40	1.3	41
42	1.2	31
44	1.1	25
46	1.1	34
48	1.0	38
50	.9	33
52	.8	29
54	.8	23
56	.8	22
58	.8	21
60	.8	18

TABLE 39 - AIRBORNE DATA SAMPLING PASS 34

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0 3	16
2	3	13
4	3	23
6	3	25
8	3	19
10	3	17
12	4	35
14	6	81
16	7	88
18	8	87
20	8	82
22	9	73
24	9	68
26	9	63
28	9	59
30	9	47
32	9	45
34	1 1	62
36	1 5	89
38	1 9	116
40	2 0	137
42	2 2	135
44	2 5	150
46	2 5	151
48	2 6	158
50	2 4	149
52	2 8	145
54	3 0	157
56	2 8	154
58	2 7	135
60	2 5	125
62	2 7	126
64	3 0	142
66	2 9	143
68	3 1	138
70	3 1	139
72	3 3	146
74	3 4	148
76	3 4	158
78	3 6	161
80	3 7	171
82	3 6	170
84	3 6	163
86	3 4	153
88	3 1	140
90	3 0	130

TABLE 40 - AIRBORNE DATA SAMPLING PASS 35

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0 4	10
2	4	12
4	4	11
6	4	10
8	4	10
10	4	13
12	5	32
14	7	63
16	1 0	110
18	1 2	125
20	1 5	129
22	1 7	134
24	2 0	141
26	2 2	147
28	2 4	151
30	2 0	149
32	1 9	109
34	2 2	117
36	2 0	125
38	1 6	85
40	1 4	48
42	1 6	51
44	1 5	63
46	1 5	72
48	1 5	68
50	2 0	86
52	2 0	119
54	2 3	116
56	2 4	123
58	2 3	111
60	2 3	107
62	2 1	99
64	1 7	73
66	1 5	48
68	1 4	36
70	1 3	47
72	1 2	35
74	1 2	26
76	1.1	21
78	1 0	22
80	1 0	23
82	9	21
84	9	20
86	9	20
88	9	18
90	9	18

TABLE 41.- AIRBORNE DATA SAMPLING PASS 36

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.4	12
2	.4	11
4	.4	11
6	.4	19
8	.4	19
10	.4	18
12	.4	18
14	.4	24
16	.5	43
18	.6	57
20	.7	66
22	.9	92
24	1.1	109
26	1.2	105
28	1.2	99
30	1.2	84
32	1.3	75
34	1.2	71
36	1.4	65
38	1.4	77
40	1.3	71
42	1.2	50
44	1.2	48
46	1.1	46
48	1.0	39
50	1.1	45
52	1.2	53
54	1.6	72
56	1.7	104
58	1.8	104
60	2.1	114
62	2.5	132
64	2.8	151
66	2.4	146
68	2.6	133

TABLE 41.- Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
70	2.7	146
72	2.8	145
74	2.8	136
76	3.0	137
78	2.6	123
80	2.5	108
82	2.6	103
84	2.6	113
86	2.7	113
88	2.4	105
90	2.0	67
92	2.2	63
94	2.3	90
96	2.3	103
98	2.2	104
100	2.0	101
102	2.0	95
104	1.9	91
106	1.8	83
108	1.6	68
110	1.5	61
112	1.4	46
114	1.3	35
116	1.1	31
118	1.1	28
120	1.1	28
122	1.1	28
124	1.0	25
126	1.0	22
128	.9	20
130	.9	18
132	.8	19
134	.8	20
136	.8	19
138	.8	19
140	.7	17

TABLE 42.- AIRBORNE DATA SAMPLING PASS 37

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0 4	9
2	.3	9
4	4	11
6	4	14
8	4	36
10	4	41
12	6	46
14	8	85
16	7	76
18	9	79
20	1 4	130
22	1 7	153
24	2 1	172
26	2 3	175
28	2 5	172
30	2 7	166
32	2 5	159
34	2.7	149
36	2 9	151
38	3 0	154
40	2 9	157
42	2 4	128
44	2 0	74
46	1 7	48
48	1 6	44
50	1 5	42
52	1 4	40
54	1 3	30
56	1 2	24
58	1 2	20
60	1 3	33
62	1 3	53
64	1 3	43
66	1 2	45
68	1 1	36
70	1 0	27
72	1 0	23
74	9	23
76	9	21
78	9	19
80	9	19
82	8	18
84	8	16
86	8	14
88	8	16
90	8	16

TABLE 43.- AIRBORNE DATA SAMPLING PASS 38

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.4	20
2	.4	17
4	.4	19
6	.4	17
8	.5	21
10	1.0	89
12	1.5	137
14	1.8	161
16	1.9	168
18	2.0	169
20	2.3	175
22	2.5	177
24	2.4	161
26	2.3	134
28	2.3	124
30	2.3	109
32	2.4	109
34	2.4	113
36	2.3	114
38	2.3	98
40	2.4	102
42	2.8	129
44	3.0	158
46	3.2	168
48	3.3	180
50	3.3	176
52	3.3	172
54	3.3	163
56	3.4	162
58	3.5	167
60	3.3	157
62	3.2	139
64	3.2	137
66	3.1	143
68	3.1	144

TABLE 43.- Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
70	3.2	147
72	3.4	150
74	3.3	154
76	3.2	156
78	3.1	149
80	3.9	144
82	3.8	130
84	2.9	125
86	2.0	145
88	2.1	154
90	3.2	153
92	3.3	152
94	3.3	151
96	3.3	148
98	3.1	134
100	3.1	129
102	3.2	142
104	3.8	127
106	3.7	111
108	2.6	118
110	2.2	86
112	2.0	66
114	2.8	56
116	2.8	51
118	1.7	50
120	1.5	40
122	1.4	34
124	1.3	31
126	1.3	30
128	1.2	28
130	1.2	27
132	1.1	26
134	1.1	25
136	1.1	24
138	1.1	22
140	1.1	25

TABLE 44.- AIRBORNE DATA SAMPLING PASS 39

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
20	0.3	10
22	.3	10
24	.4	27
26	.5	70
28	.6	88
30	.7	98
32	.8	94
34	1.1	127
36	1.4	148
38	2.0	174
40	2.2	188
42	2.4	189
44	2.3	179
46	2.4	165
48	2.1	143
50	1.9	103
52	1.9	100
54	1.5	69
56	1.4	41
58	1.3	26
60	1.1	22
62	1.0	19
64	1.0	18
66	1.0	17
68	.9	17
70	.9	16

TABLE 45.- AIRBORNE DATA SAMPLING PASS 40

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0 5	12
2	5	12
4	5	14
6	5	19
8	6	29
10	6	37
12	7	42
14	9	70
16	9	90
18	1 1	90
20	1 3	112
22	1 6	126
24	1 7	134
26	1 9	133
28	2 0	136
30	1 9	125
32	1 8	99
34	1 7	86
36	1 7	71
38	1 5	59
40	1.5	57
42	1 6	62
44	1 8	74
46	1 8	83
48	2 0	94
50	2 1	108
52	2 1	107
54	2 2	104
56	2 2	109
58	2 0	103
60	2 1	98
62	2 1	96
64	1 8	85
66	1.6	67
68	1 3	48
70	1 2	33
72	1 1	25
74	9	22
76	9	21
78	9	20
80	9	23
82	8	25
84	8	26
86	8	25
88	8	25
90	8	28

TABLE 46.- AIRBORNE DATA SAMPLING PASS 41

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.8	61
2	.9	69
4	1.0	77
6	.9	73
8	1.0	72
10	1.1	79
12	1.4	95
14	1.4	100
16	1.4	95
18	1.4	91
20	1.5	92
22	1.8	111
24	2.0	129
26	1.9	119
28	1.9	107
30	1.9	100
32	1.8	85
34	1.8	76
36	2.0	86
38	1.8	86
40	1.8	71
42	1.9	78
44	1.9	93
46	2.0	92
48	2.1	91
50	2.2	99
52	2.2	105
54	2.2	97
56	2.1	93
58	2.0	102

TABLE 46.- Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
60	1.7	75
62	1.9	66
64	2.0	84
66	2.1	92
68	2.2	103
70	2.3	100
72	2.4	101
74	2.4	103
76	2.4	109
78	2.2	108
80	2.1	91
82	1.9	76
84	1.8	67
86	1.8	67
88	1.5	55
90	1.6	51
92	1.7	70
94	1.7	83
96	1.7	88
98	1.6	65
100	1.5	48
102	1.4	42
104	1.3	39
106	1.2	36
108	1.2	31
110	1.1	29
112	1.1	26
114	1.0	23
116	1.0	23
118	1.0	22

TABLE 47.- AIRBORNE DATA SAMPLING PASS 42

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.4	11
2	.4	10
4	.4	21
6	.5	45
8	.7	61
10	1.0	114
12	1.5	157
14	1.9	176
16	2.0	176
18	2.2	171
20	2.3	169
22	2.4	156
24	2.5	151
26	2.4	153
28	2.3	140
30	2.4	118
32	2.3	102
34	2.2	95
36	2.0	88
38	1.8	62
40	1.6	41
42	1.4	28
44	1.3	22
46	1.3	21
48	1.2	20
50	1.0	22
52	1.1	21
54	1.0	20
56	.9	19
58	.9	20
60	.8	17

TABLE 48.- AIRBORNE DATA SAMPLING PASS 43

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.6	22
2	.6	20
4	.6	20
6	.6	22
8	.6	25
10	.6	31
12	.7	40
14	.8	52
16	.9	65
18	1.0	78
20	1.0	74
22	1.2	75
24	1.5	110
26	1.4	119
28	1.5	107
30	1.4	106
32	1.3	85
34	1.2	64
36	1.1	51
38	1.0	48
40	1.1	63
42	1.1	67
44	1.0	46
46	.9	31
48	.8	25
50	.8	20
52	.8	17
54	.7	16
56	.7	15
58	.7	14
60	.6	13

TABLE 49.- AIRBORNE DATA SAMPLING PASS 44

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.3	11
2	.3	10
4	.3	10
6	.3	11
8	.3	17
10	.4	43
12	.6	66
14	1.0	110
16	1.4	139
18	1.6	152
20	1.6	146
22	1.7	134
24	1.7	122
26	1.8	114
28	1.8	111
30	1.9	107
32	1.8	106
34	1.7	91
36	1.6	80
38	1.5	76
40	1.5	69
42	1.7	76
44	1.6	81
46	1.4	59
48	1.3	41
50	1.2	37
52	1.2	42
54	1.2	46
56	1.4	58
58	1.5	79

TABLE 49.- Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
60	1.6	89
62	1.7	93
64	1.9	99
66	2.1	107
68	2.0	106
70	2.2	101
72	2.3	104
74	2.3	107
76	2.3	110
78	2.3	113
80	2.3	108
82	2.4	107
84	2.4	105
86	2.7	105
88	2.8	120
90	3.0	136
92	2.7	139
94	3.0	147
96	3.2	149
98	2.7	143
100	2.2	104
102	1.9	63
104	1.6	41
106	1.5	31
108	1.4	26
110	1.2	22
112	1.2	22
114	1.2	22
116	1.1	22
118	1.0	22
120	1.0	23

TABLE 50.- AIRBORNE DATA SAMPLING PASS 45

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.3	9
2	.3	8
4	.3	10
6	.3	11
8	.3	10
10	.3	14
12	.5	54
14	.9	117
16	1.3	151
18	1.7	160
20	2.0	169
22	2.1	164
24	2.1	151
26	2.1	130
28	1.8	116
30	1.8	96
32	1.7	102
34	1.4	69
36	1.2	41
38	1.1	26
40	1.1	19
42	1.1	17
44	1.0	15
46	1.0	16
48	.9	15
50	.9	14
52	.8	15
54	.8	15
56	.8	15
58	.7	16
60	.7	16

TABLE 51 - AIRBORNE DATA SAMPLING PASS 46

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	1 1	56
2	1 0	33
4	9	23
6	9	25
8	9	30
10	1.0	39
12	1.0	42
14	1 1	47
16	1 1	41
18	1 1	38
20	1 1	33
22	1 1	39
24	1 2	60
26	1 2	70
28	1 3	73
30	1 6	101
32	1 5	124
34	1 4	105
36	1 2	70
38	1 1	40
40	.9	25
42	9	20
44	8	20
46	8	18
48	8	15
50	7	17
52	7	17
54	.6	17
56	7	29
58	1.1	81
60	1 4	119
62	1.7	135
64	1 8	136
66	1 8	114
68	1.7	90
70	1.8	82
72	1 7	73
74	2 0	79
76	1 9	87
78	2 1	91
80	2 4	120
82	2.5	143
84	2 6	155
86	2.8	162
88	3 0	169

TABLE 51.- Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
90	3 2	179
92	3 3	183
94	3 4	184
96	3 4	180
98	3 4	167
100	3 3	162
102	3 3	162
104	3 4	158
106	3 4	159
108	3 2	149
110	3 3	142
112	3 6	154
114	3 5	163
116	3 7	169
118	4 0	169
120	4.0	164
122	4 0	163
124	4.0	166
126	3 9	164
128	4 1	167
130	4 2	171
132	4 1	173
134	3 6	142
136	3 4	121
138	3 4	128
140	3 6	151
142	3 7	165
144	3 6	175
146	3 5	167
148	3.2	160
150	3 5	173
152	3 1	165
154	2 7	147
156	3 4	123
158	1 9	76
160	1.7	51
162	1 5	39
164	1 8	35
166	1.6	29
168	1 1	29
170	1 1	31
172	1 4	29
174	1 3	30
176	1 3	29
178	9	30
180	1 3	31

TABLE 52.- AIRBORNE DATA SAMPLING PASS 47

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.4	13
2	.4	11
4	.4	12
6	.4	12
8	.4	16
10	.4	19
12	.4	33
14	.6	69
16	.9	89
18	1.1	126
20	1.3	140
22	1.6	143
24	1.7	145
26	1.8	140
28	1.9	140
30	1.9	134
32	1.8	110
34	1.8	112
36	1.6	82
38	1.4	48
40	1.2	33
42	1.1	26
44	1.1	23
46	.9	18
48	.9	15
50	.8	16
52	.8	14
54	.7	15
56	.7	16
58	.6	17
60	.6	16

TABLE 53.- AIRBORNE DATA SAMPLING PASS 48

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0 3	9
2	2	9
4	2	11
6	2	12
8	.2	24
10	3	40
12	3	42
14	4	53
16	5	100
18	.7	116
20	1 0	149
22	1 3	166
24	1 4	165
26	1.6	167
28	1 9	168
30	2 1	173
32	2 3	174
34	2 4	168
36	2.4	164
38	2 5	154
40	2 4	146
42	2 4	142
44	2 4	132
46	2 4	133
48	2 3	125
50	2 2	113
52	2 0	93
54	1.9	81
56	1 8	71
58	1 8	63
60	1 8	82
62	1 6	63
64	1 6	54
66	1 6	73
68	1 7	76
70	1 8	78
72	1 8	88
74	1 8	96
76	1 9	98
78	2 0	105
80	2 1	111
82	2 1	115
84	2 3	118
86	2 4	123
88	2.3	117

TABLE 53 - Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
90	2.4	120
92	2 4	119
94	2.4	115
96	2 4	112
98	2.5	113
100	2 6	114
102	2 6	119
104	2.7	134
106	2.9	143
108	3 0	146
110	3.1	146
112	3 1	150
114	3.2	153
116	3.1	153
118	3 0	162
120	2 4	112
122	2 1	73
124	2 0	58
126	2 2	79
128	2 3	119
130	2 4	122
132	2 4	119
134	2 3	116
136	2.3	116
138	2 5	133
140	2 4	133
142	2 1	89
144	1 8	55
146	1 6	38
148	1 5	33
150	1 4	29
152	1 3	26
154	1 3	27
156	1 2	25
158	1 1	26
160	1 1	25
162	1 0	24
164	1 0	21
166	1 0	22
168	9	21
170	9	23
172	9	23
174	8	22
176	8	21
178	.8	21
180	.8	20

TABLE 54.- AIRBORNE DATA SAMPLING PASS 49

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
10	0.4	13
12	.4	12
14	.4	12
16	.4	10
18	.4	11
20	.4	27
22	.8	81
24	1.2	134
26	1.5	158
28	1.9	165
30	2.0	160
32	2.0	143
34	2.1	128
36	2.1	125
38	1.9	100
40	1.7	67
42	1.5	42
44	1.4	27
46	1.2	20
48	1.1	18
50	1.0	17
52	1.0	15
54	.9	14
56	.9	13
58	.8	13
60	.8	13

TABLE 55.- AIRBORNE DATA SAMPLING PASS 50

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
0	0.9	21
2	.8	20
4	.8	18
6	.8	19
8	.9	41
10	1.1	106
12	1.1	95
14	1 1	81
16	1.2	84
18	1.2	82
20	1.3	89
22	1 4	95
24	1.7	117
26	1 6	112
28	1.8	112
30	2.1	129
32	2 1	127
34	2.3	122
36	2 2	118
38	2.2	101
40	2.3	110
42	2.4	117
44	2.6	128
46	2.5	131
48	2.4	125
50	2.4	128
52	2.5	131
54	2.4	129
56	2.5	129
58	2.5	137
60	2.6	141
62	2.8	146
64	2.6	147
66	2.9	137
68	2.9	146
70	2.5	122
72	2.3	92
74	2 1	78
76	1.8	54
78	1 8	56

TABLE 55 - Concluded

Reference time, sec	HCl concentration, ppm	Particle concentration (nephelometer), $\mu g/m^3$
80	1.8	60
82	2.1	97
84	2.4	133
86	2.9	156
88	3 2	169
90	2.6	138
92	2.2	93
94	2.0	58
96	1.7	42
98	1.7	39
100	2.0	85
102	2.3	123
104	2.6	146
106	2.7	155
108	2.7	151
110	2.9	153
112	3 1	155
114	2.9	141
116	2.8	124
118	2.8	136
120	2 7	130
122	2 5	111
124	2.3	88
126	2.1	78
128	2.0	71
130	1.9	56
132	1.8	50
134	1.7	46
136	1.6	38
138	1.5	31
140	1.4	31
142	1.3	30
144	1.3	27
146	1.3	27
148	1.3	27
150	1.2	26

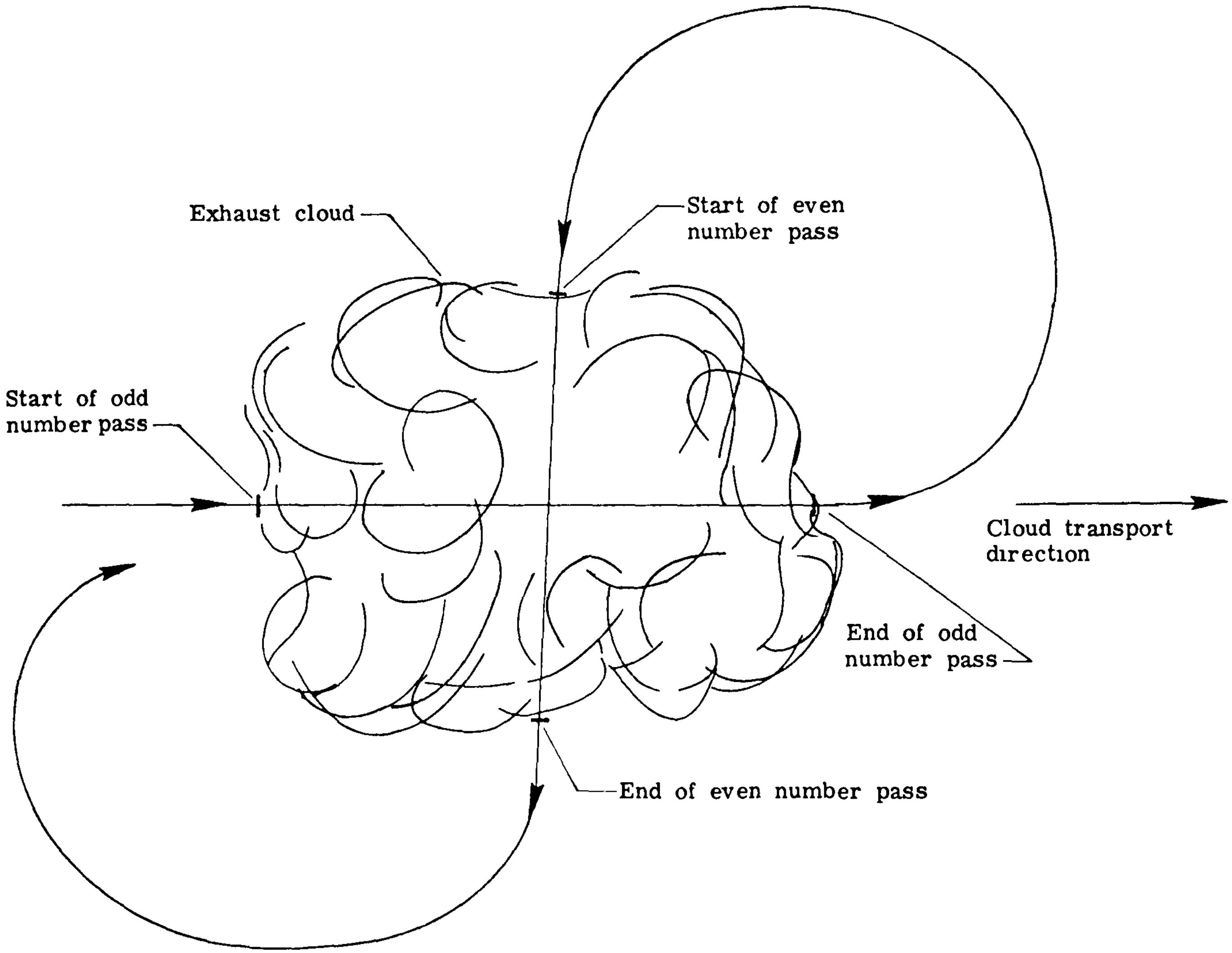


Figure 1.- Basic aircraft sampling plan, downwind and crosswind (plan view). Alternate odd and even number passes may be at varying altitudes.

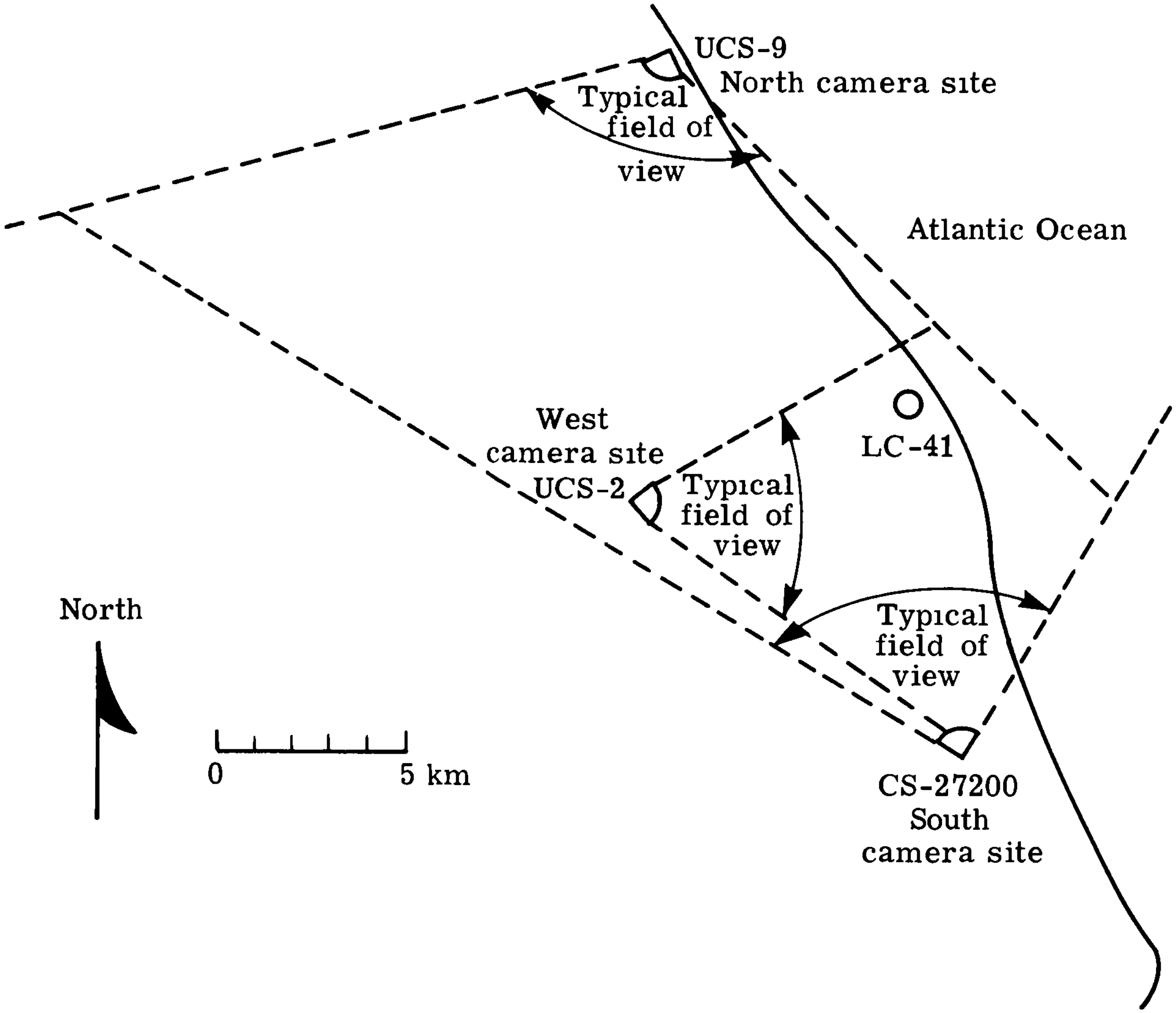


Figure 2.- Camera-site plan.

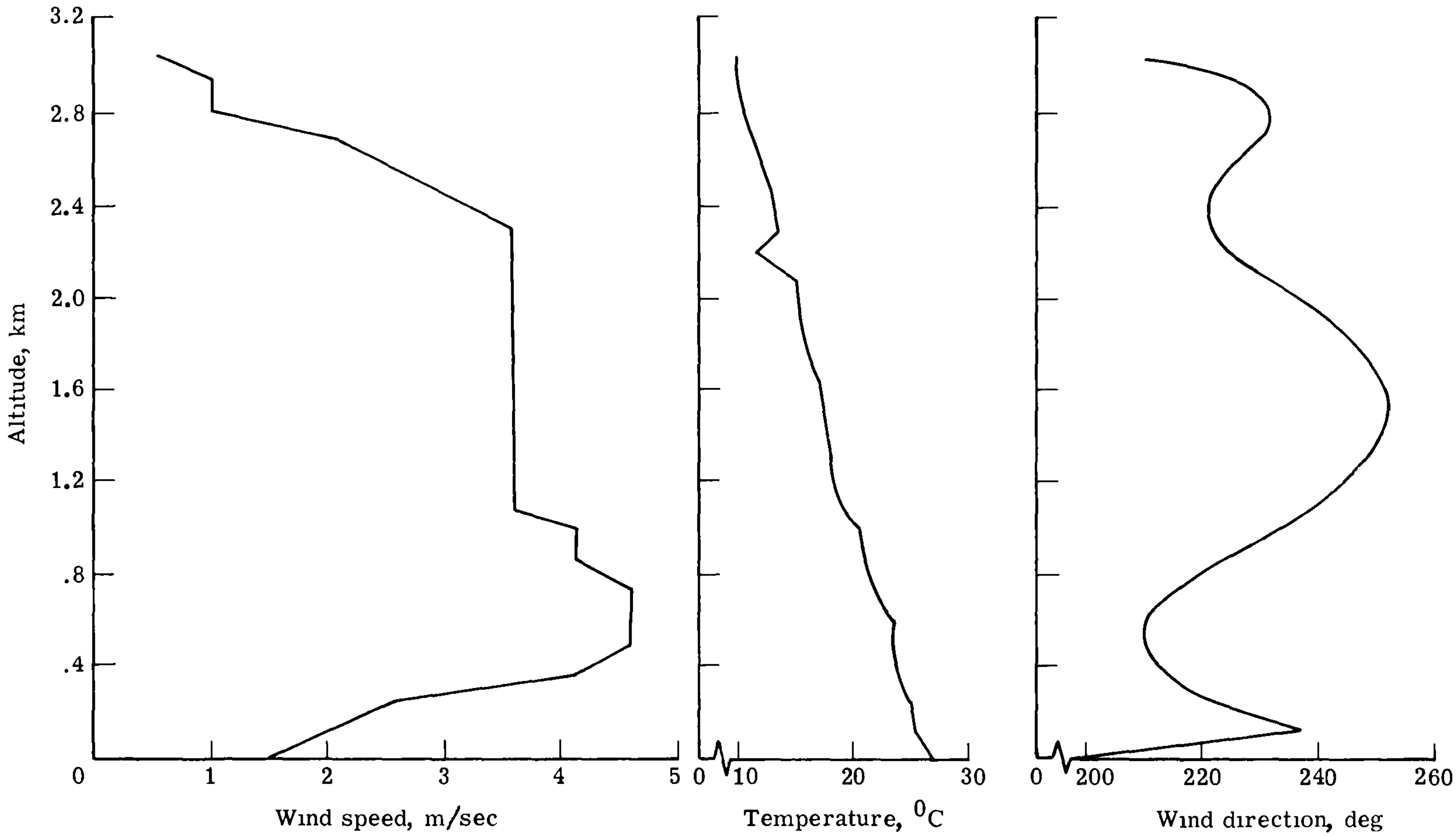


Figure 3.- Launch meteorological data (rawinsonde release at T + 28 minutes).

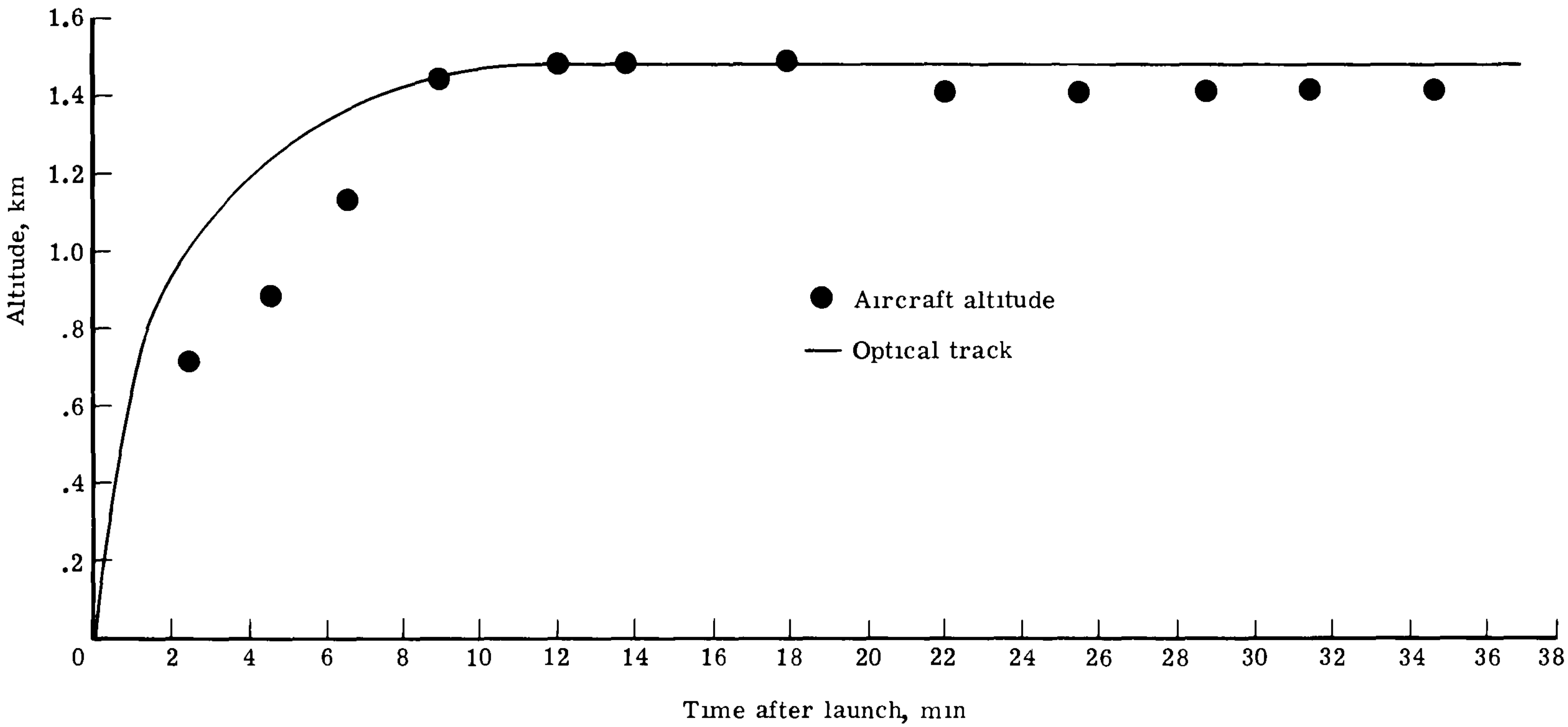


Figure 4.- Cloud-rise data.

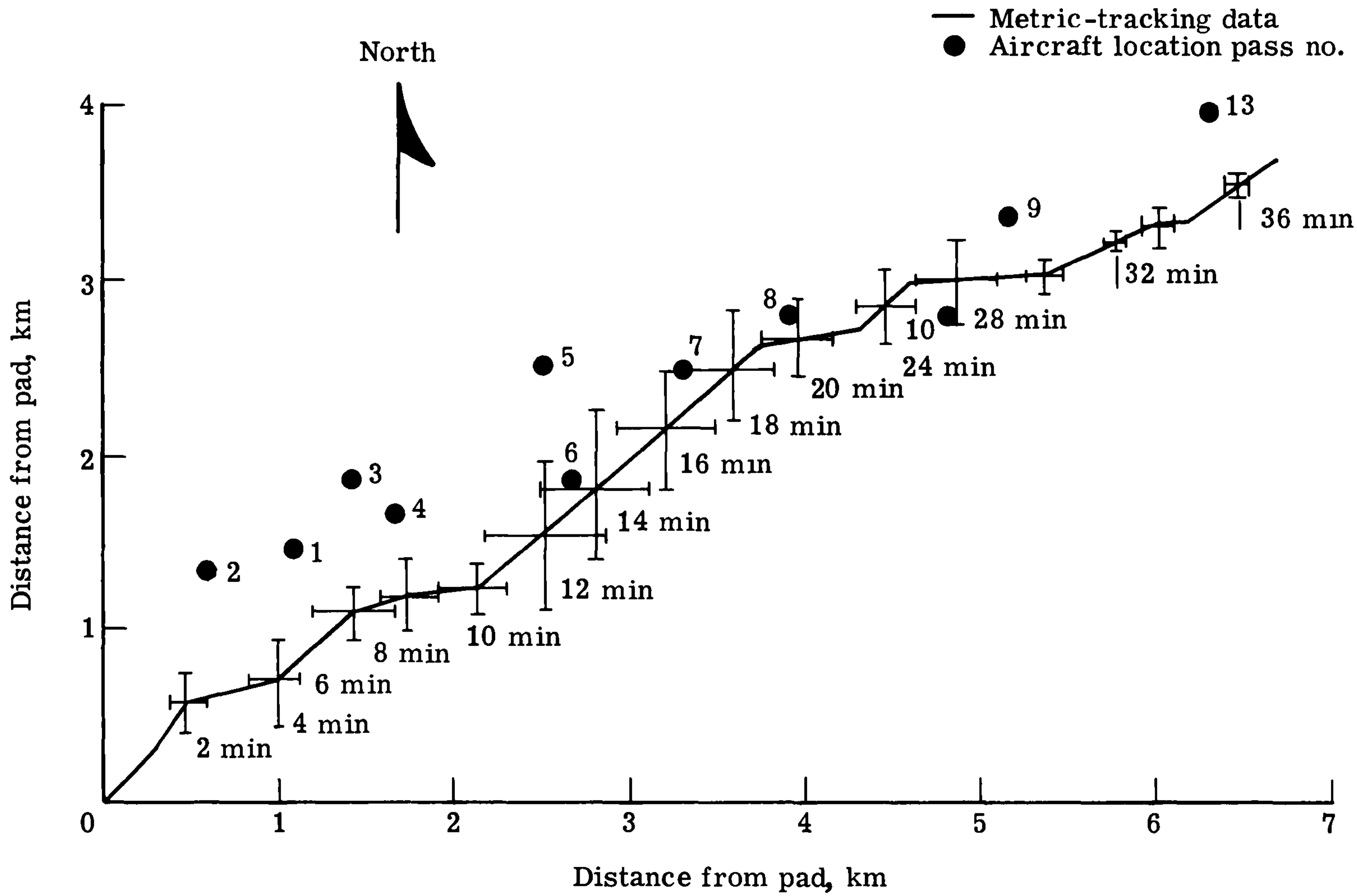


Figure 5.- Cloud trajectory data.

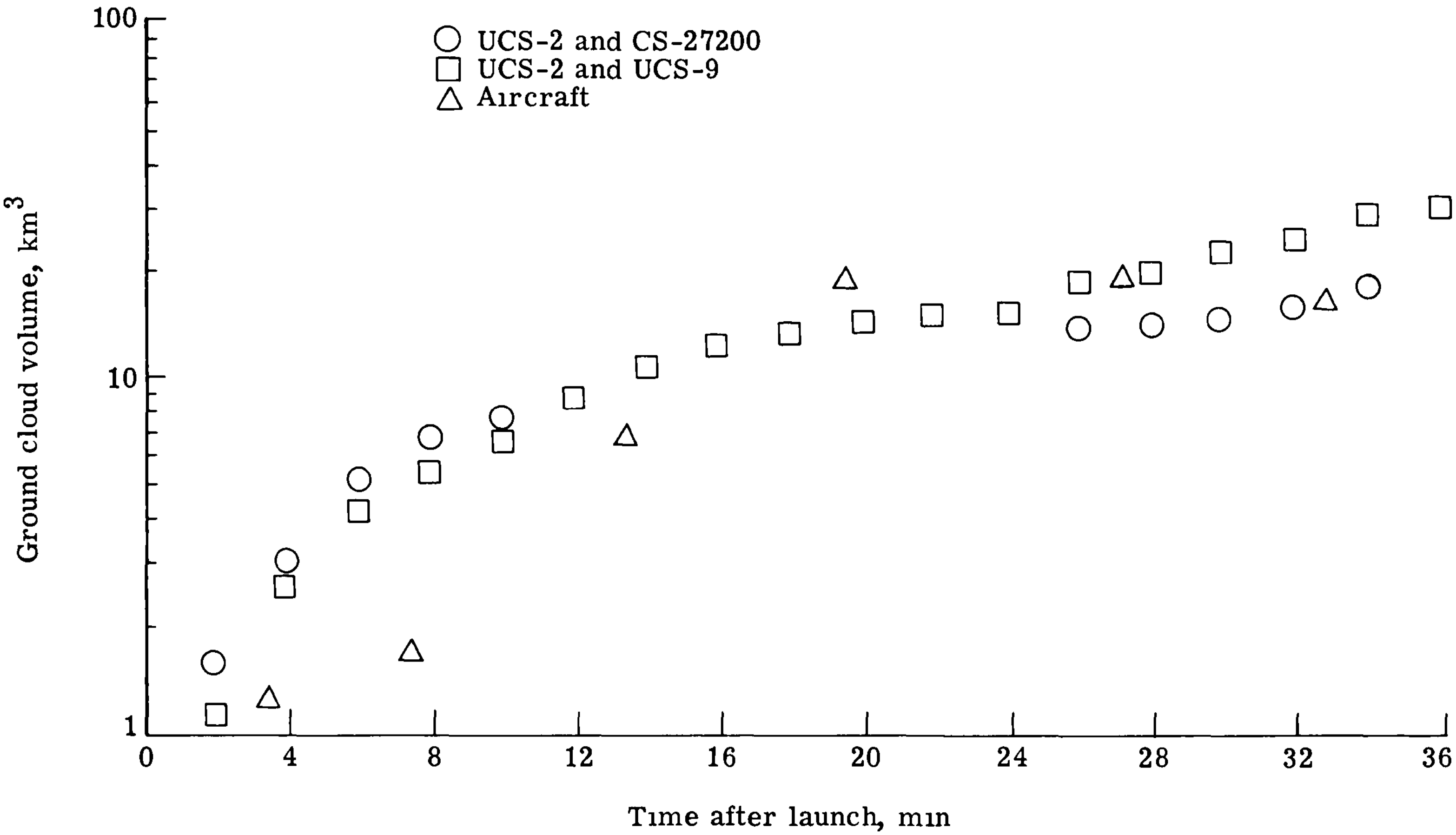


Figure 6.- Cloud volume data. T + 0 minutes to T + 36 minutes.

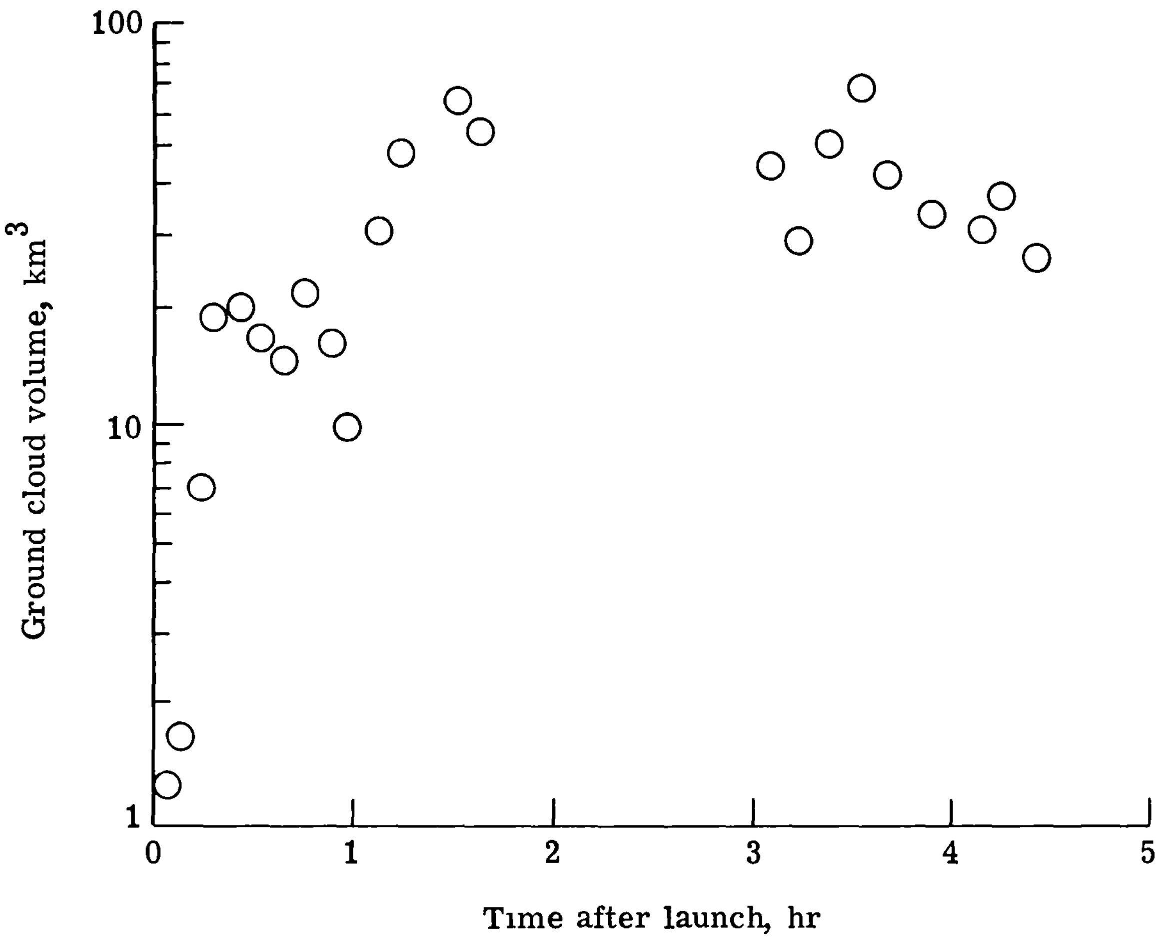


Figure 7.- Cloud-volume data calculated from aircraft results.

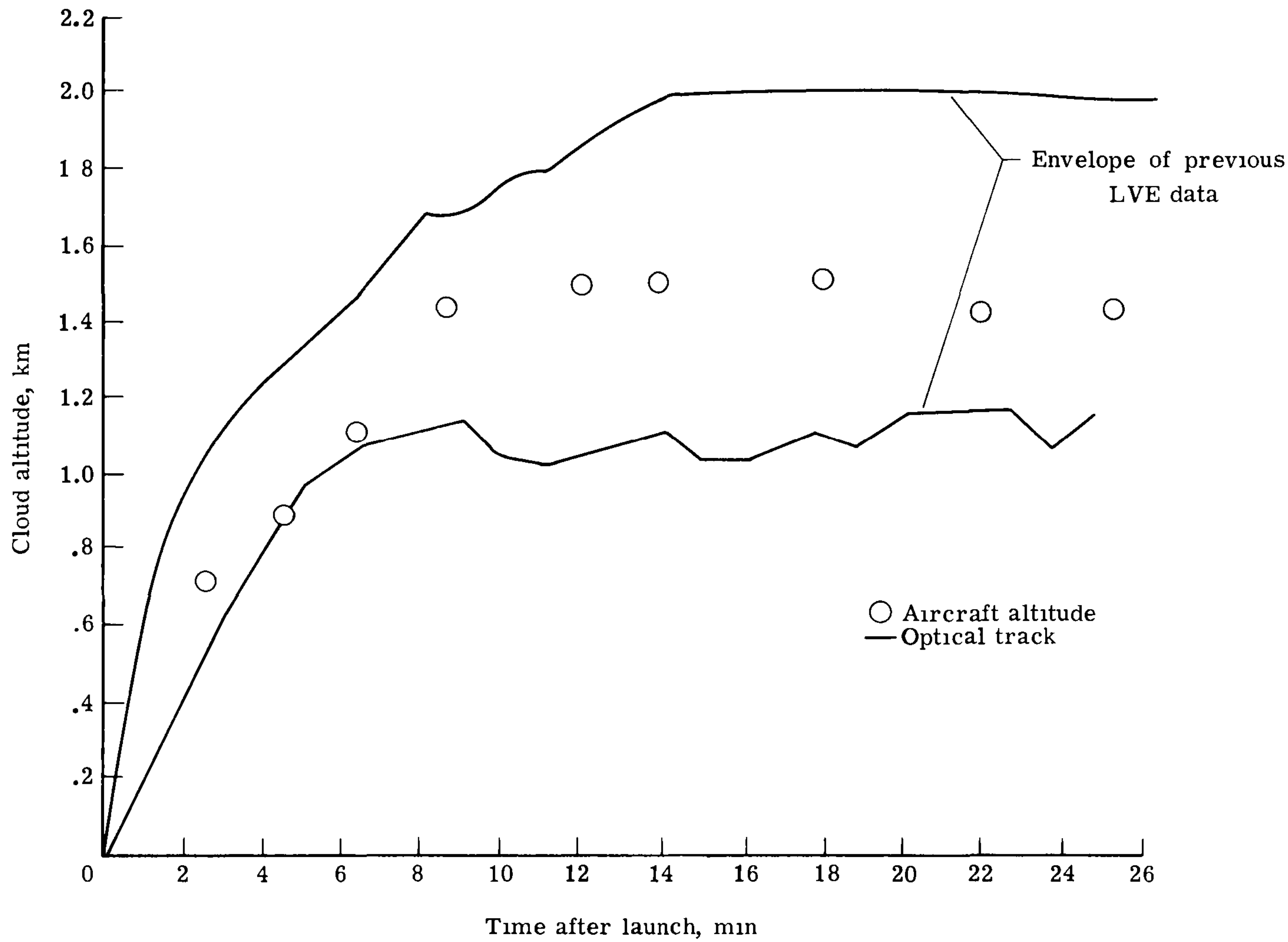


Figure 8.- Comparison of cloud-rise data.

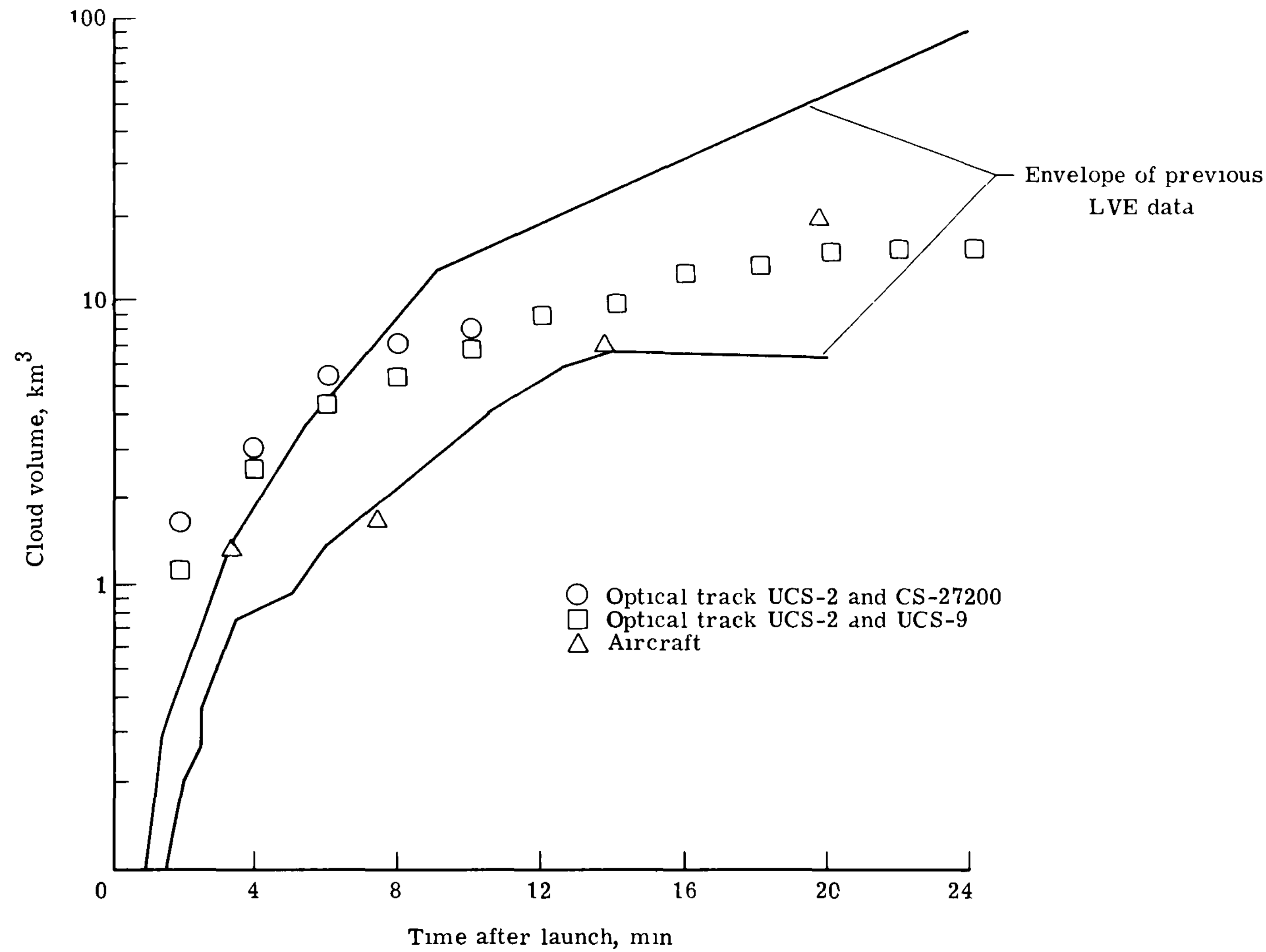
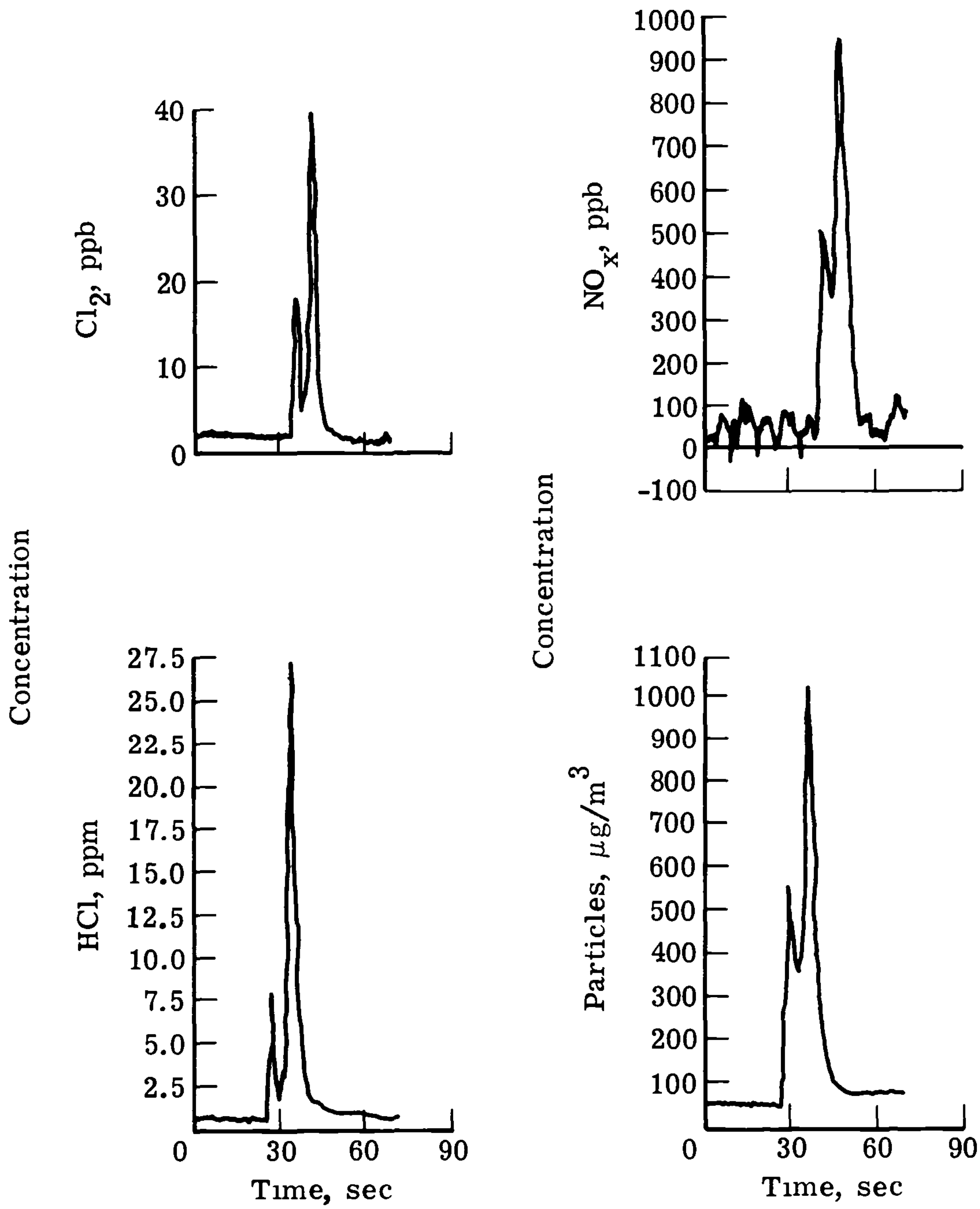
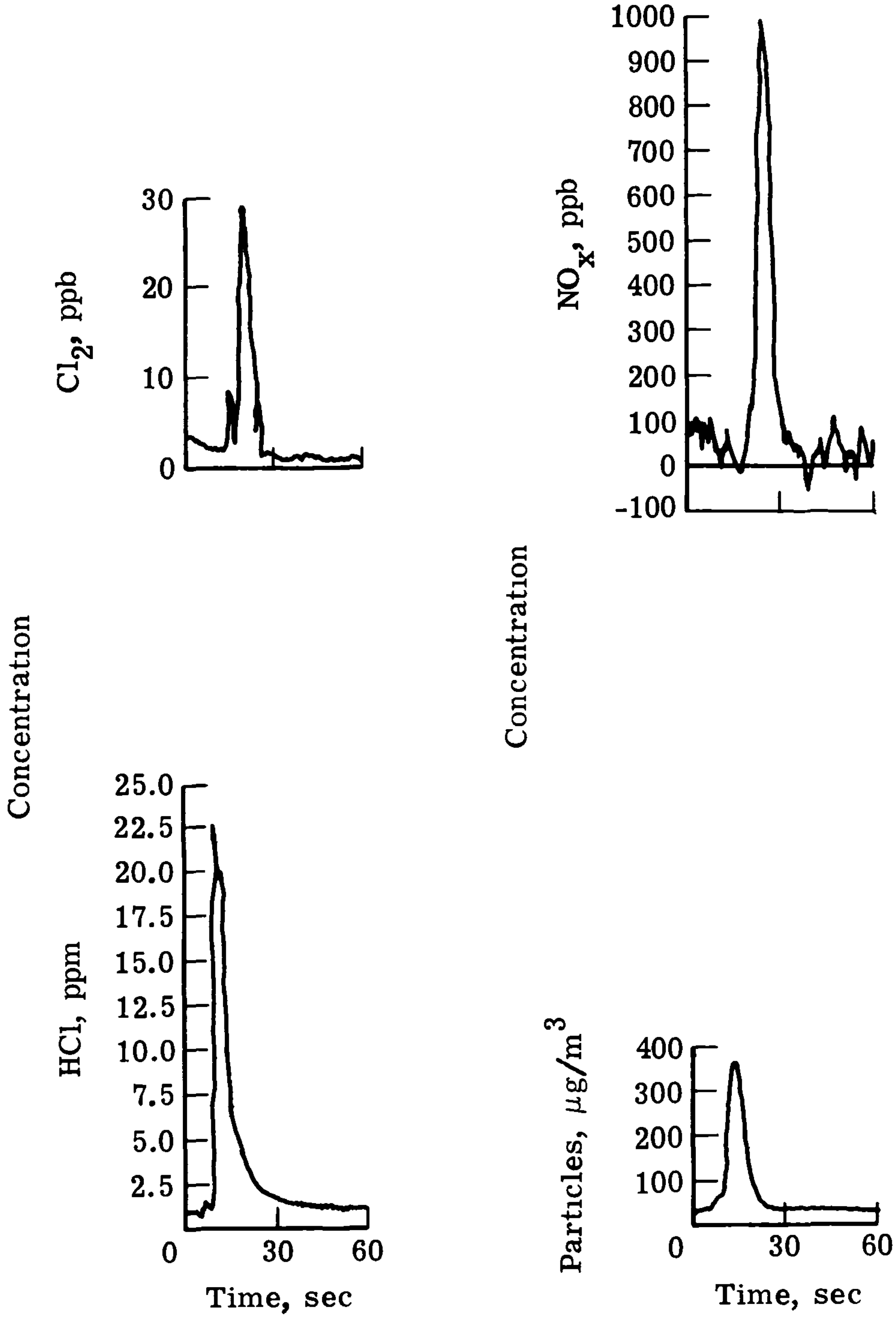


Figure 9.- Comparison of cloud-volume data.



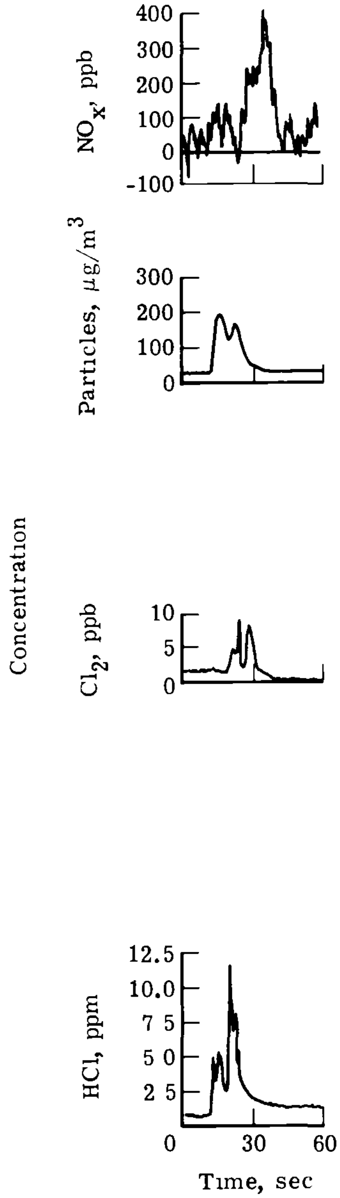
(a) Pass 1; t_0 = 0858:00 EDT.

Figure 10.- Concentration-time data for September 5, 1977, launch.

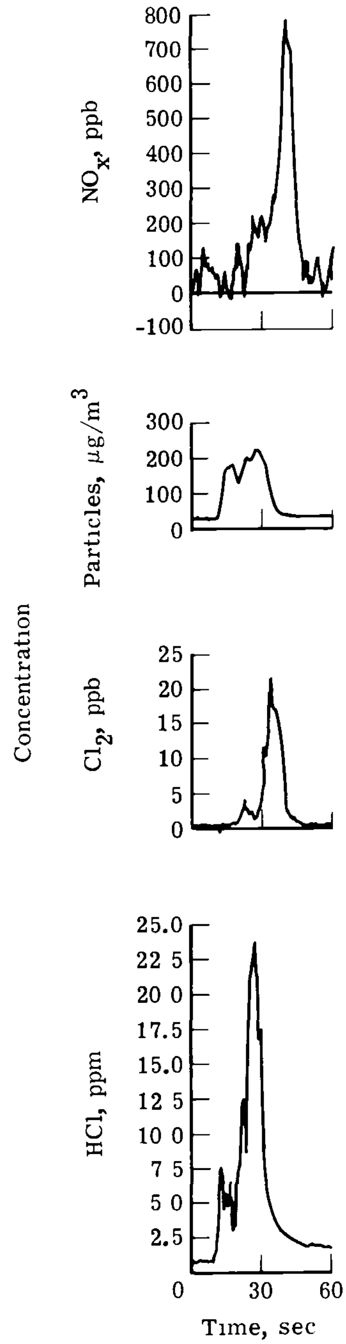


(b) Pass 2; t_0 = 0900:00 EDT.

Figure 10.- Continued.

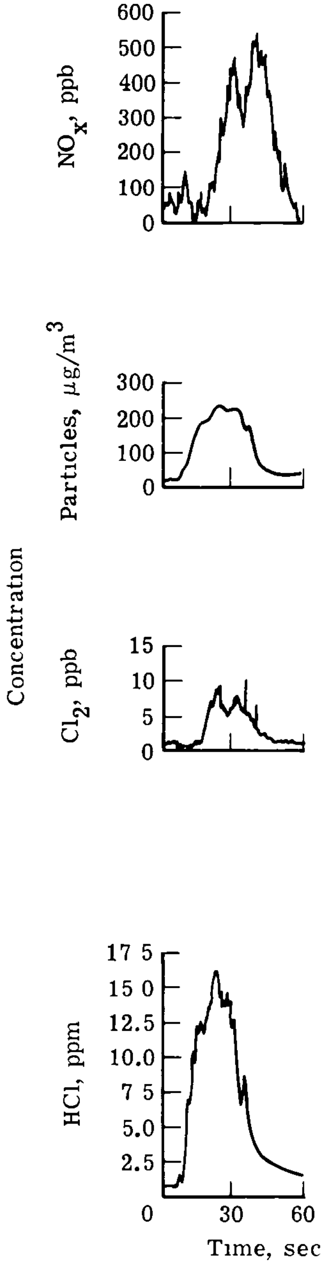


(c) Pass 3; t_0 = 0902:00 EDT.

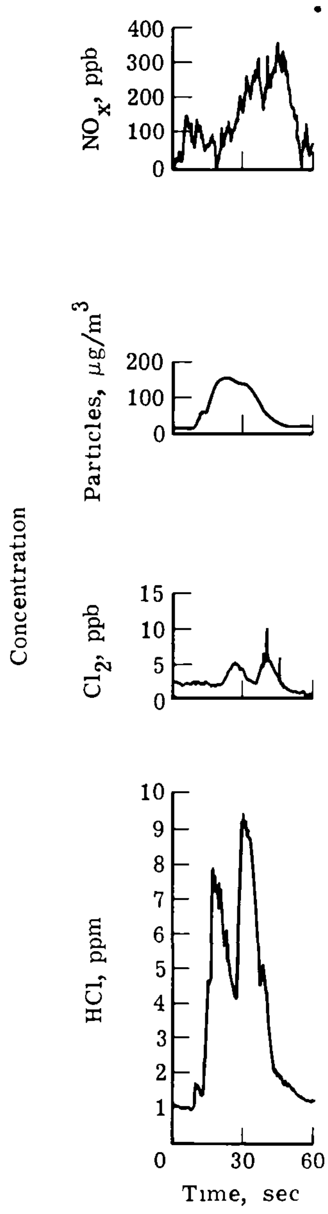


(d) Pass 4; t_0 = 0904:30 EDT.

Figure 10.- Continued.

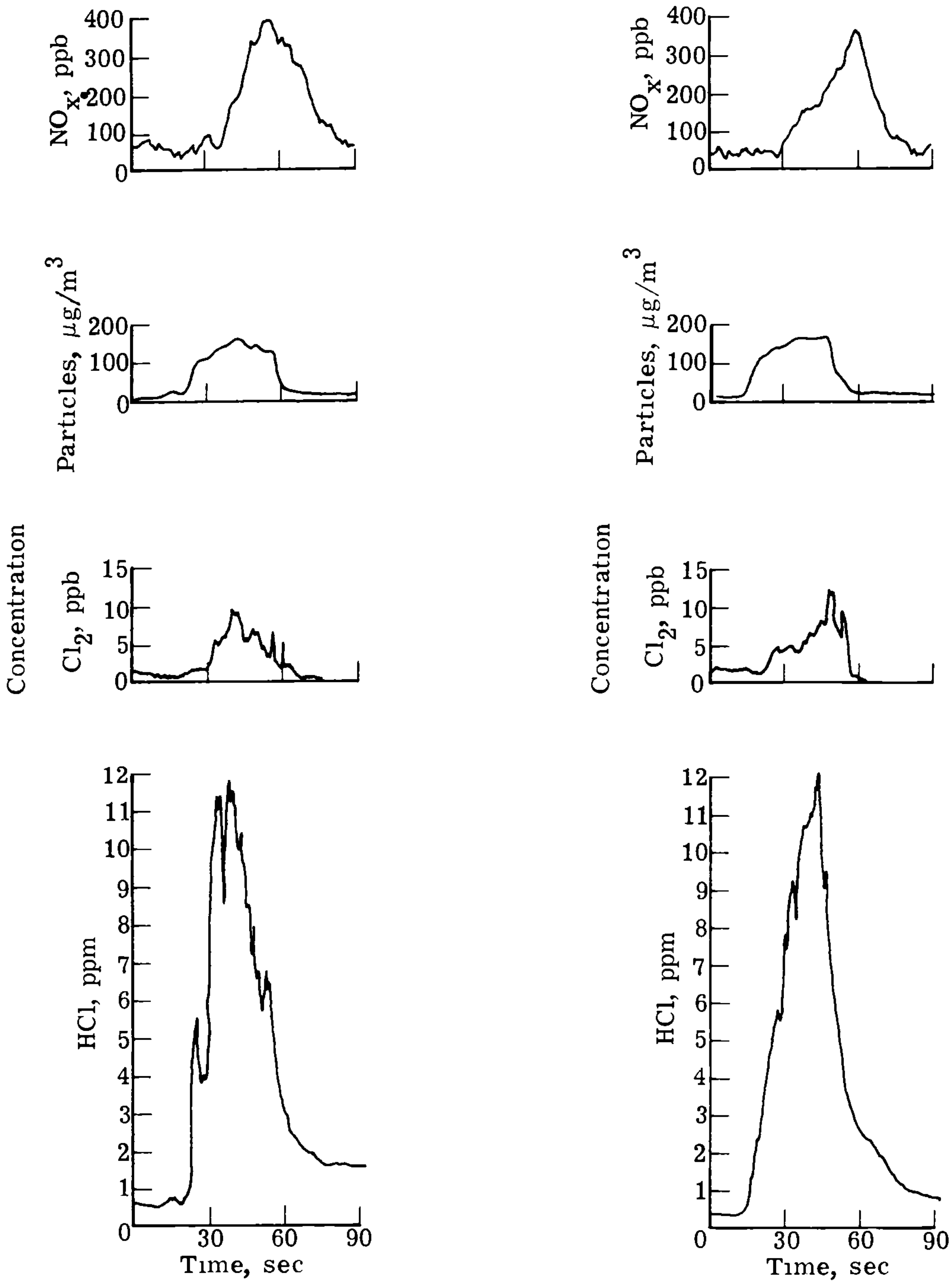


(e) Pass 5; t_0 = 0907:50 EDT.



(f) Pass 6; t_0 = 0910:25 EDT.

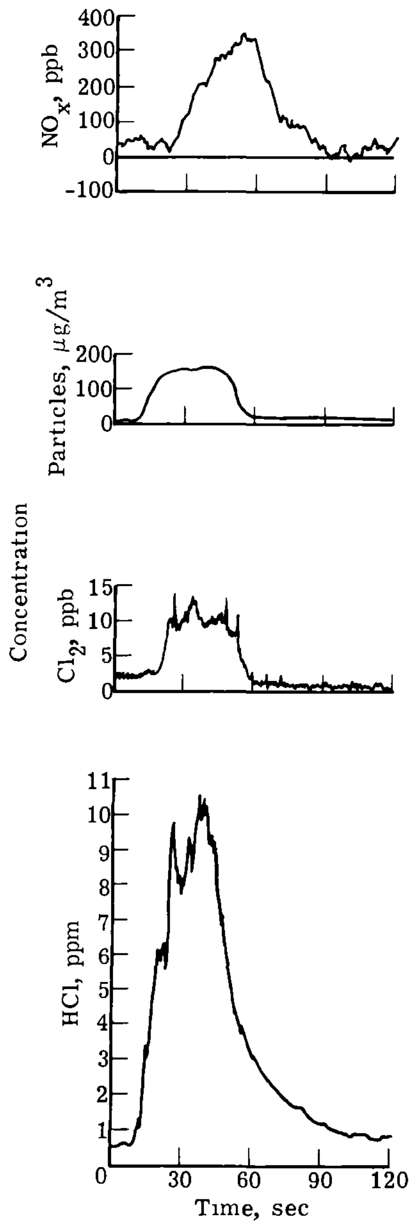
Figure 10.- Continued.



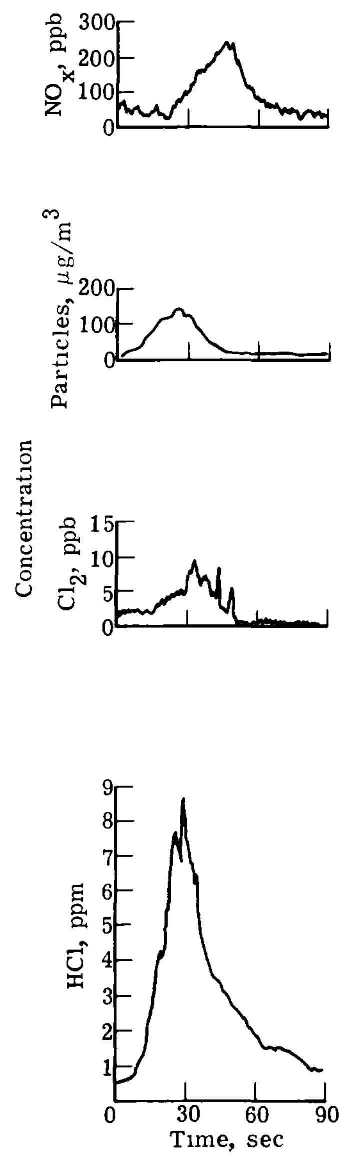
(g) Pass 7; t_0 = 0913:00 EDT.

(h) Pass 8; t_0 = 0917:15 EDT.

Figure 10.- Continued.

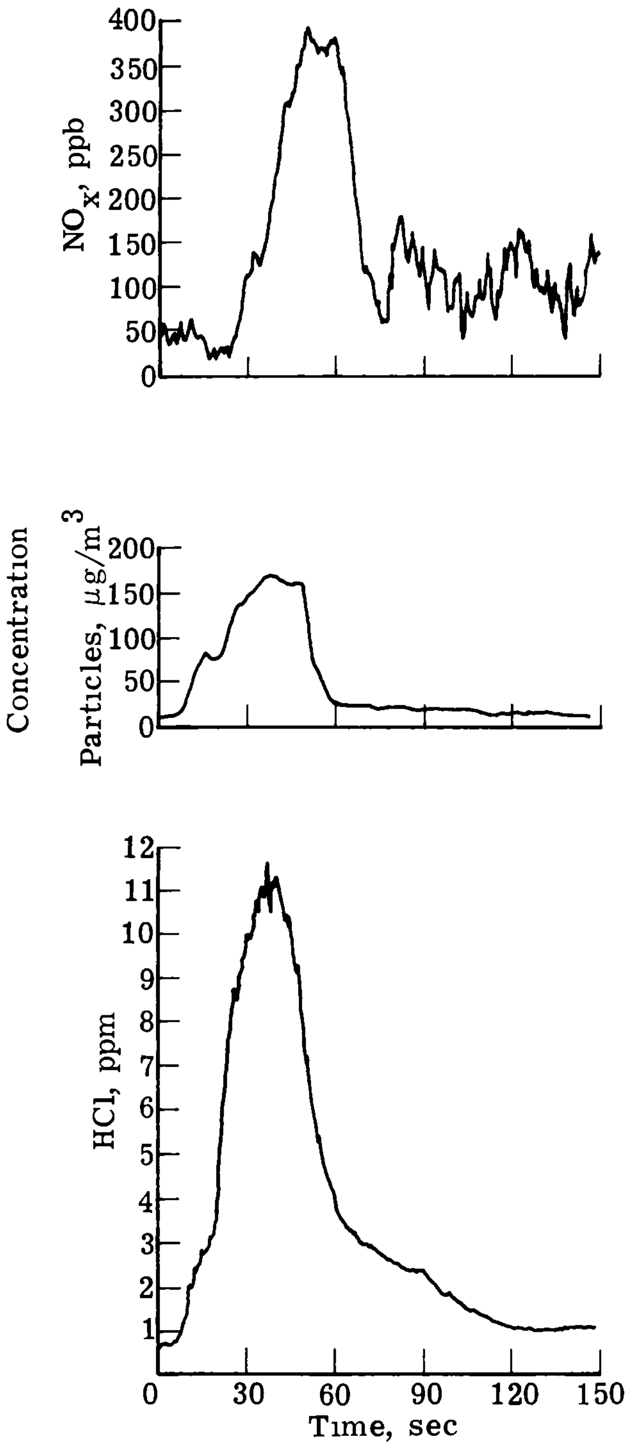


(i) Pass 9; t_0 = 0920:50 EDT.

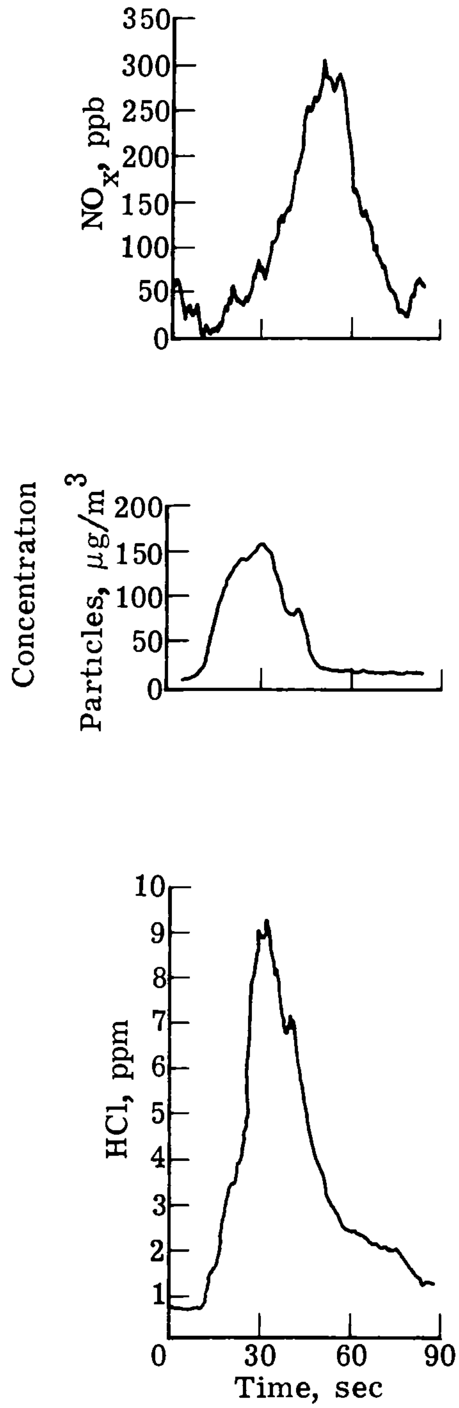


(j) Pass 10; t_0 = 0924:00 EDT.

Figure 10.- Continued.

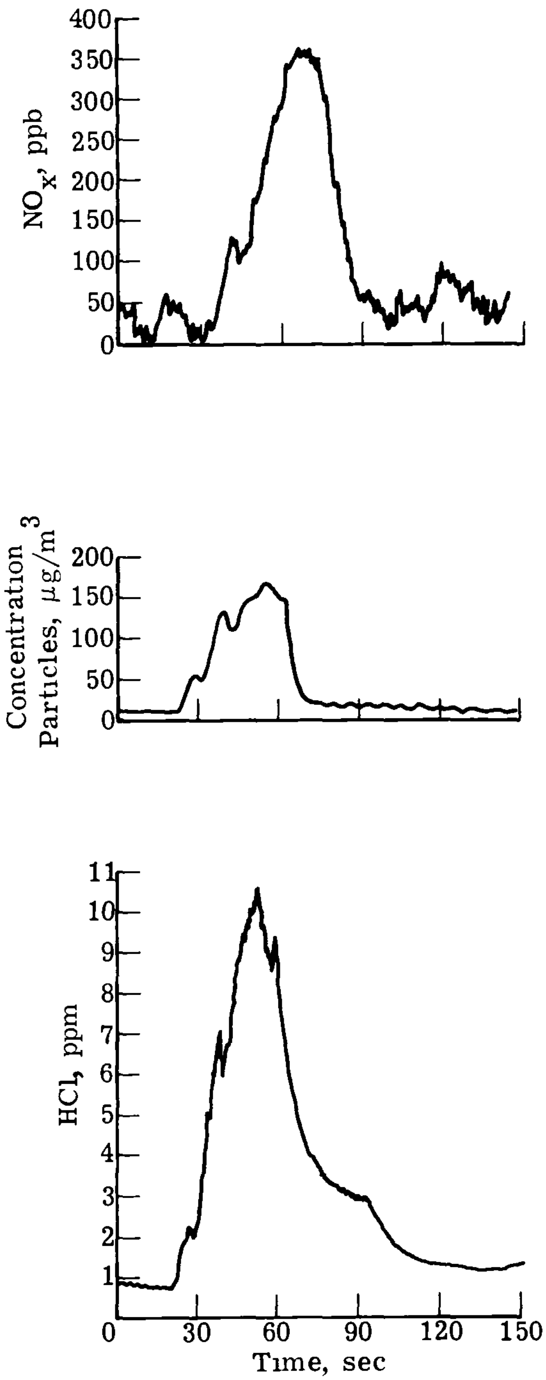


(k) Pass 11; t_0 = 0926:25 EDT.

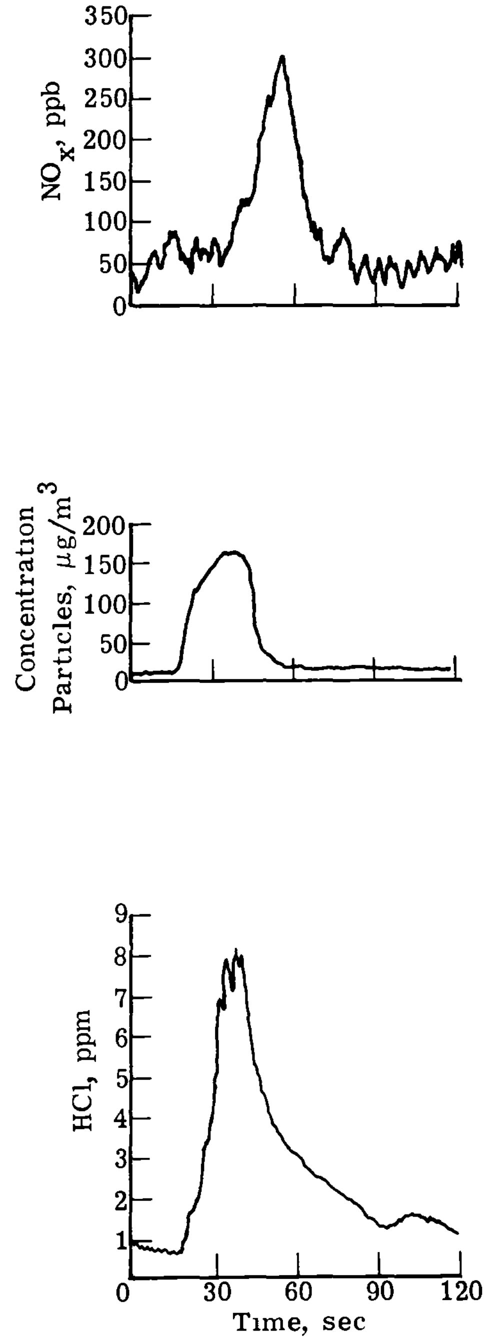


(l) Pass 12; t_0 = 0929:45 EDT.

Figure 10.- Continued.

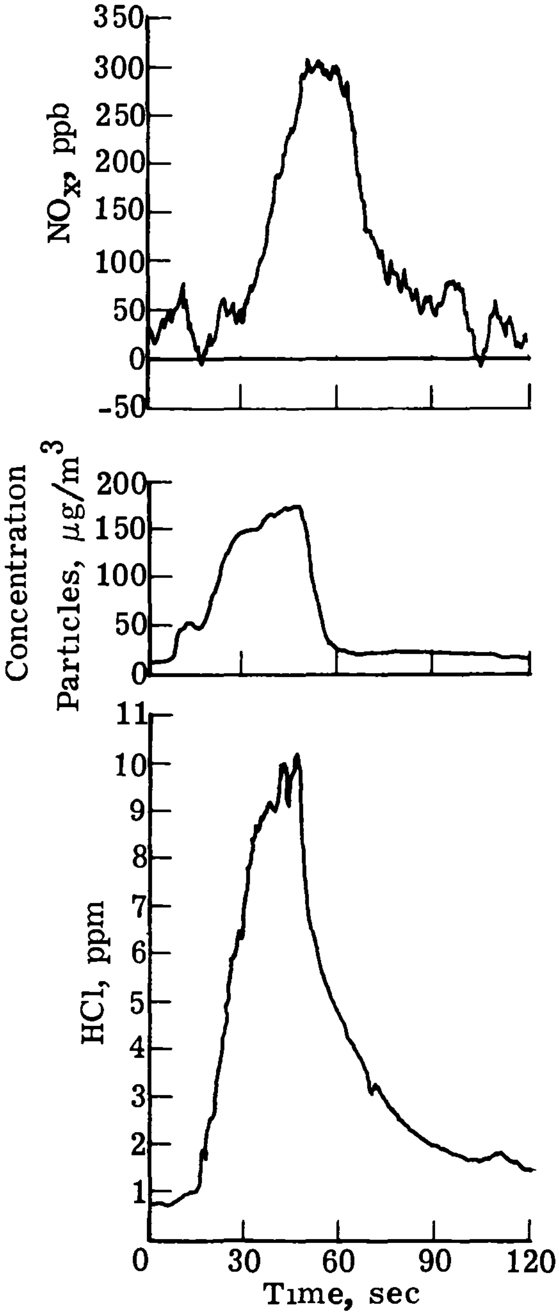


(m) Pass 13; t_0 = 0933:00 EDT.

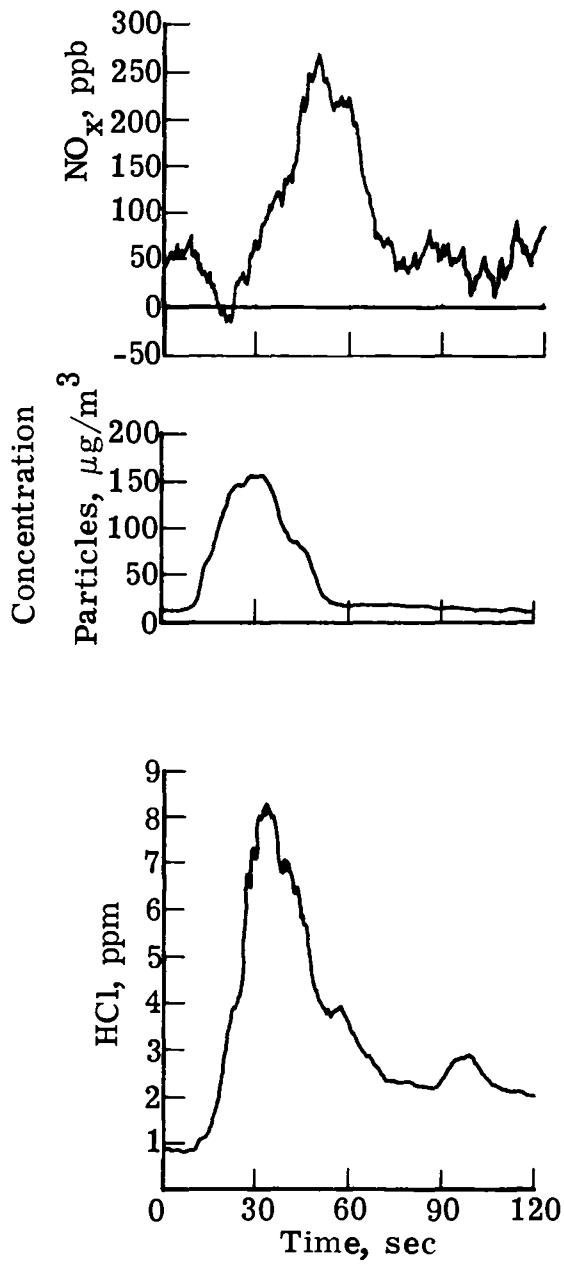


(n) Pass 14; t_0 = 0937:00 EDT.

Figure 10.- Continued.

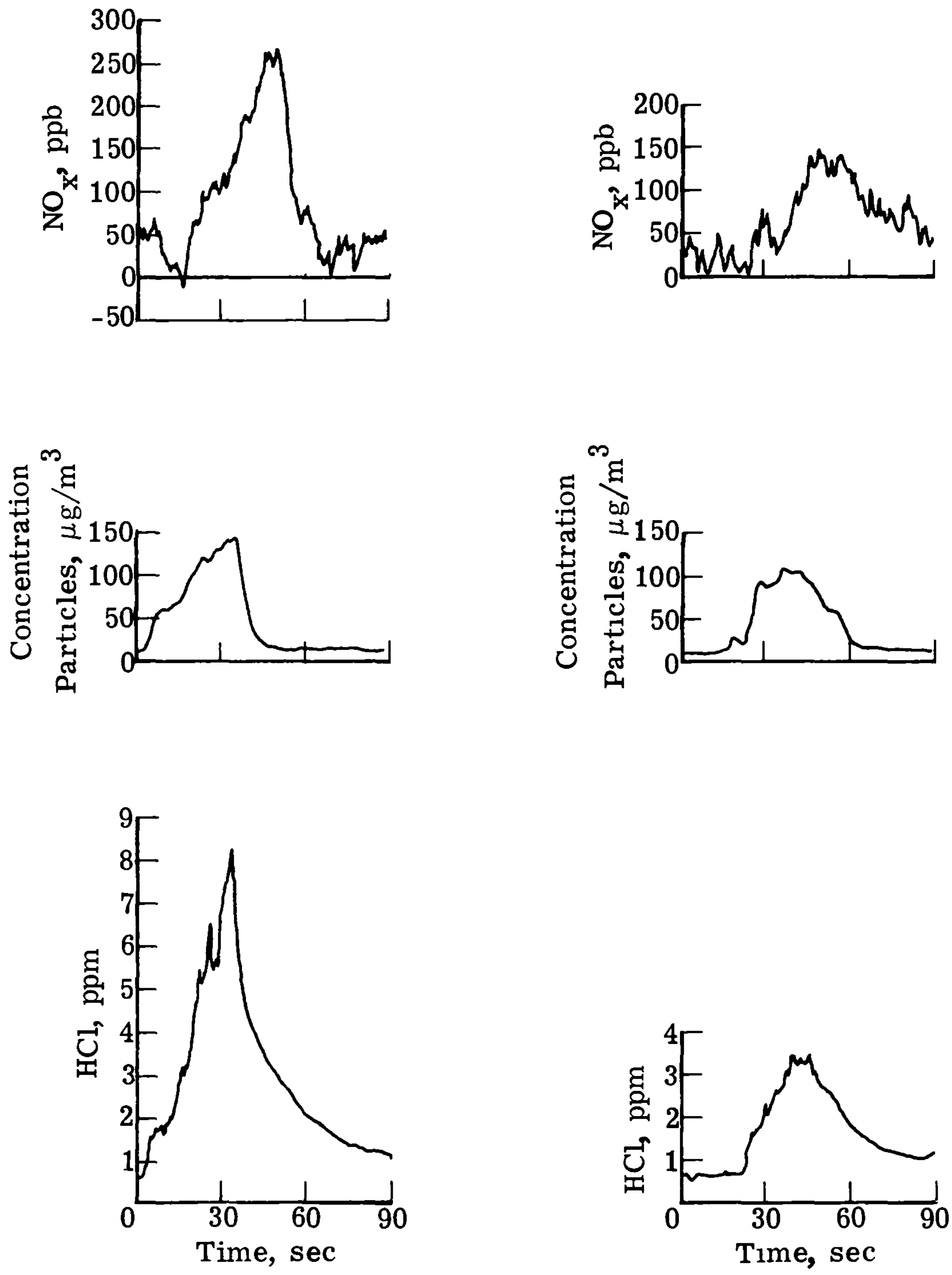


(o) Pass 15; t_0 = 0940:00 EDT.



(p) Pass 16; t_0 = 0943:35 EDT.

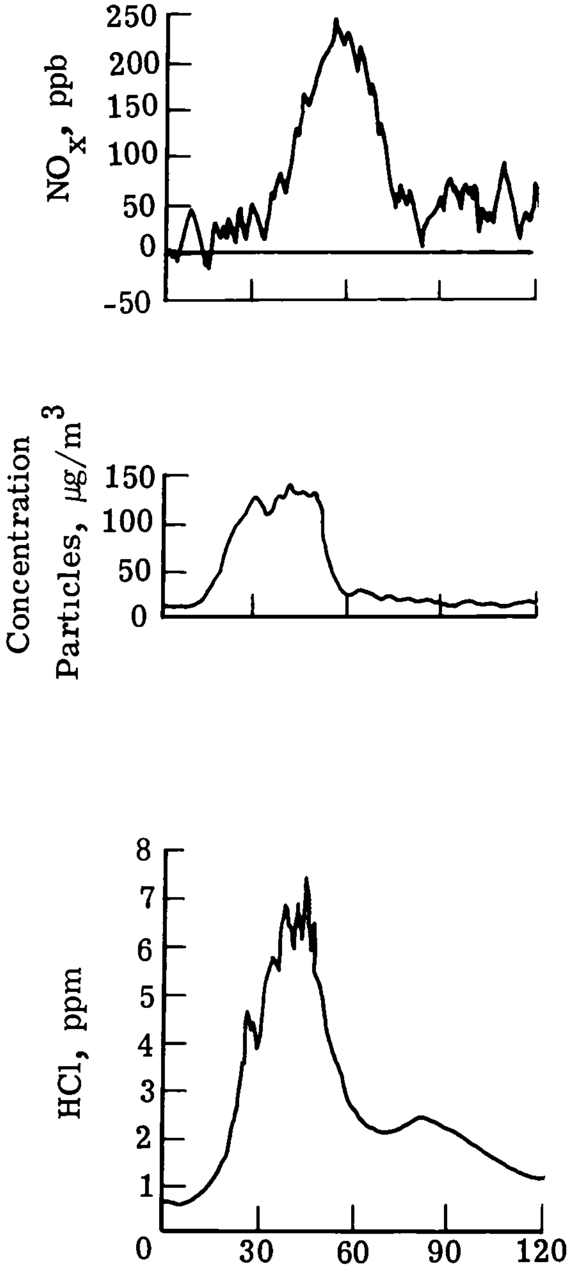
Figure 10.- Continued.



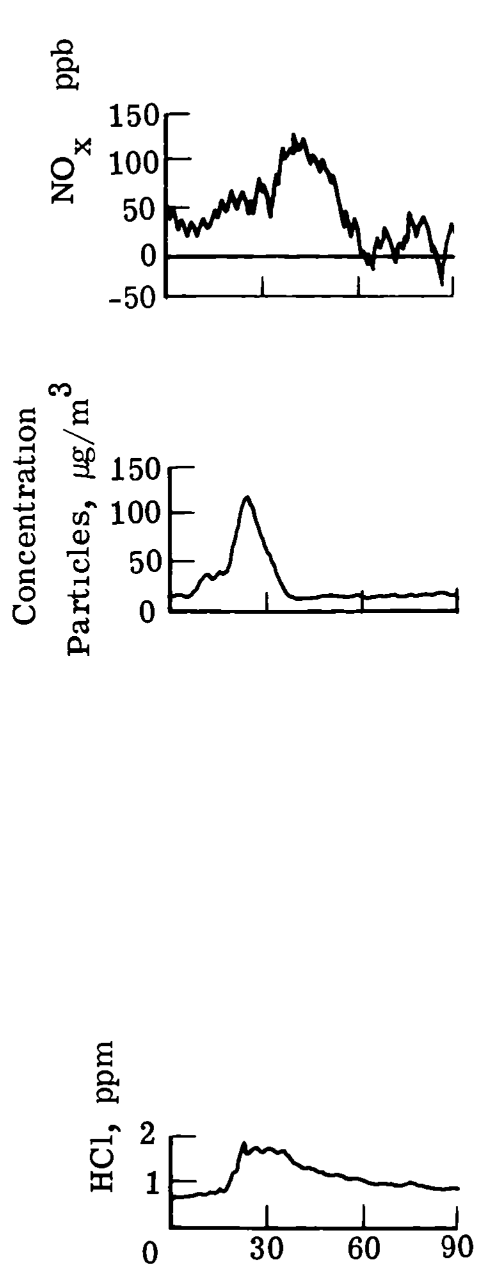
(q) Pass 17; t_0 = 0947:35 EDT.

(r) Pass 18; t_0 = 0951:10 EDT.

Figure 10.- Continued.

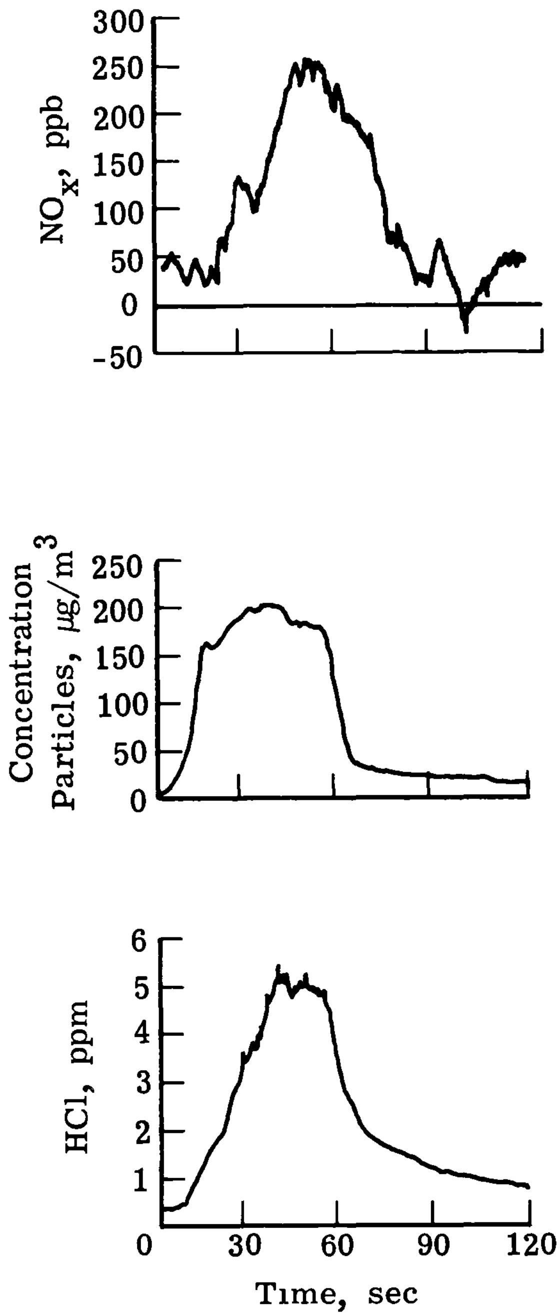


(s) Pass 19, t_0 = 0954:05 EDT.

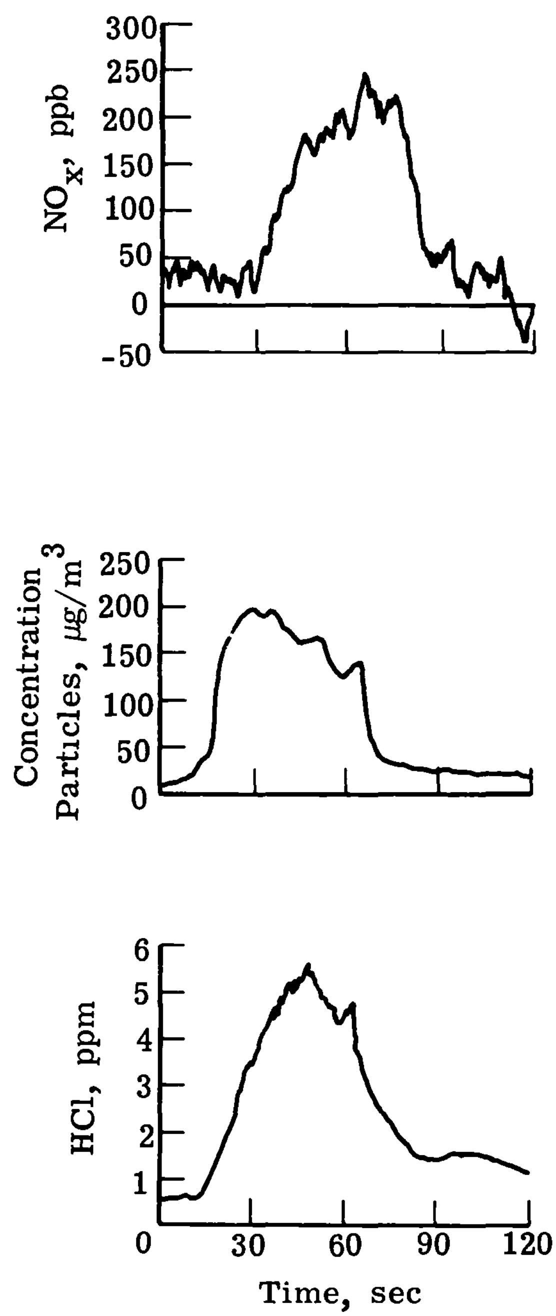


(t) Pass 20; t_0 = 0957:20 EDT.

Figure 10.- Continued.

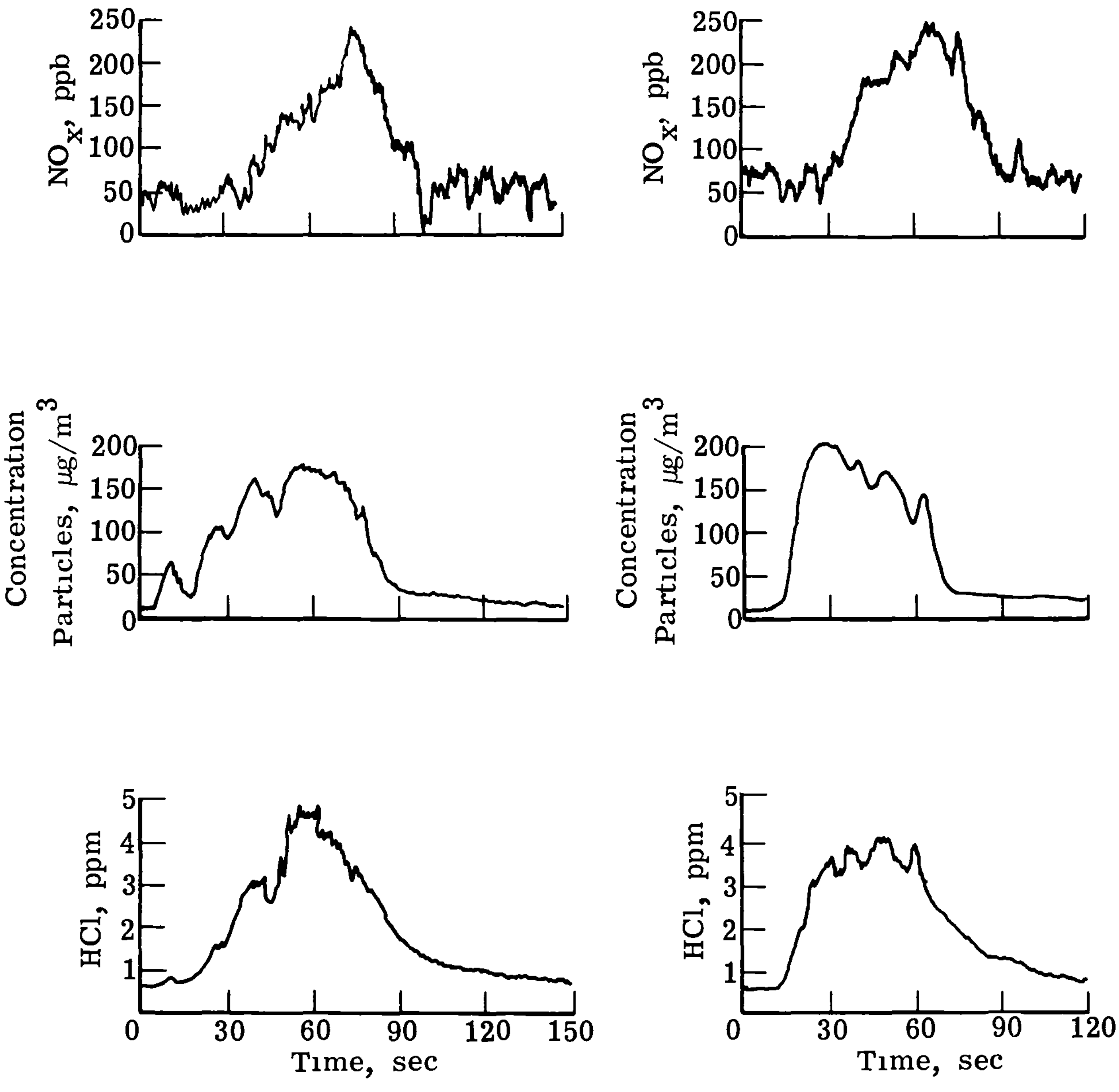


(u) Pass 21; t_0 = 1001:30 EDT.



(v) Pass 22; t_0 = 1004:35 EDT.

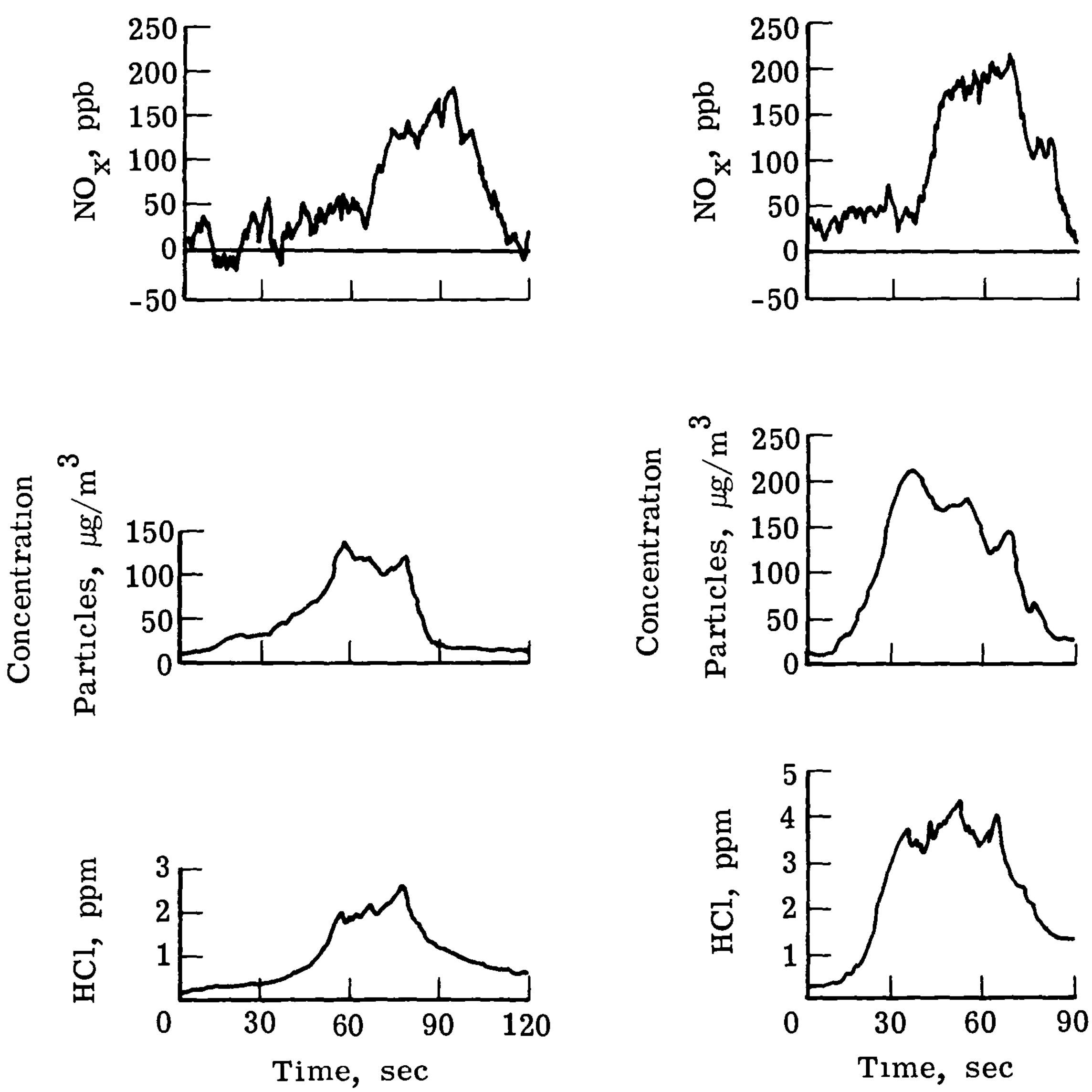
Figure 10.- Continued.



(w) Pass 23; t_0 = 1007:30 EDT.

(x) Pass 24; t_0 = 1011:10 EDT.

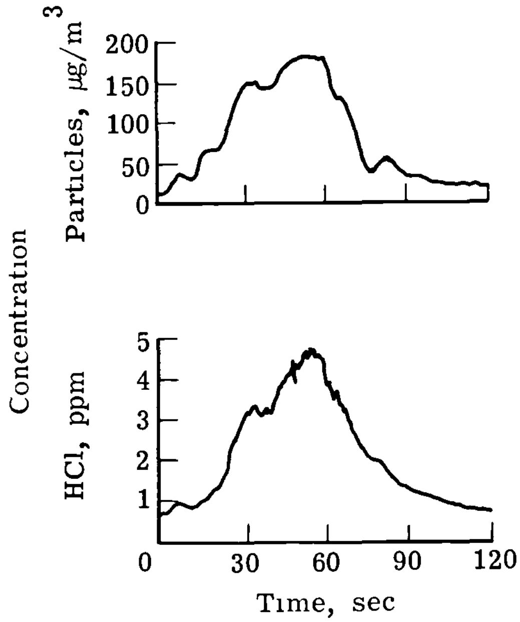
Figure 10.- Continued.



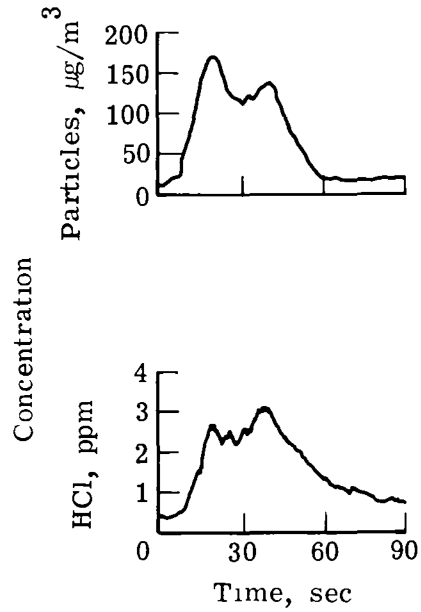
(y) Pass 25, t_0 = 1024:00 EDT.

(z) Pass 26; t_0 = 1028:00 EDT.

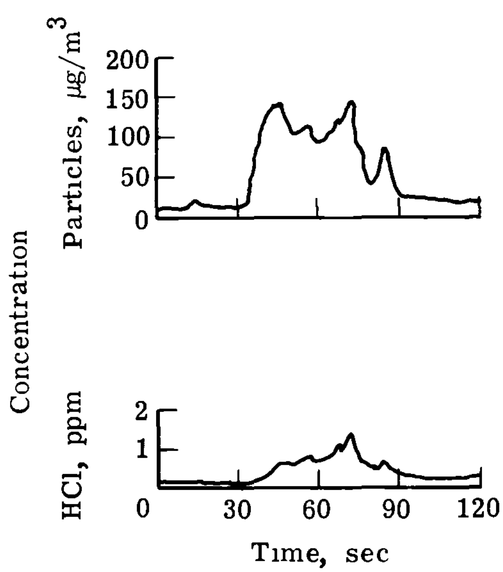
Figure 10.- Continued.



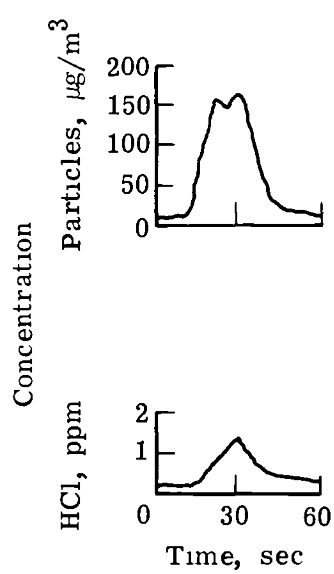
(aa) Pass 27; t_0 = 1030:30 EDT.



(bb) Pass 28; t_0 = 1034:05 EDT.

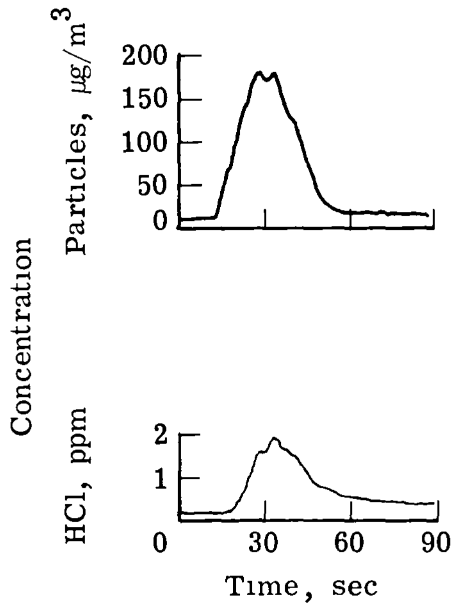


(cc) Pass 29; t_0 = 1157:29 EDT.

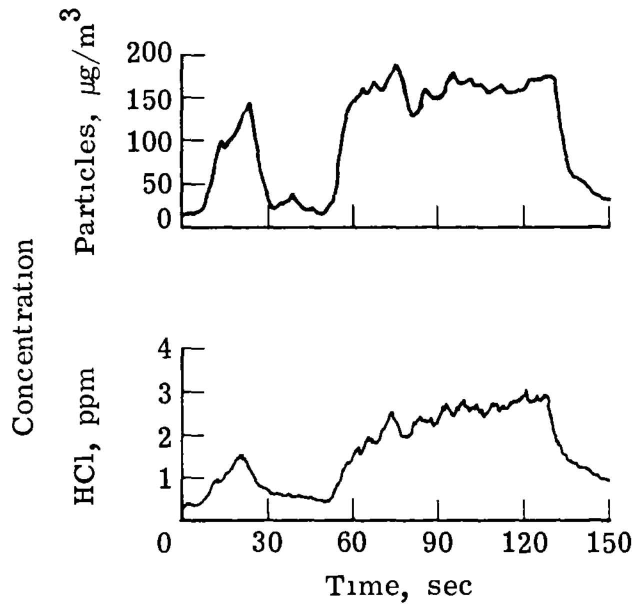


(dd) Pass 30; t_0 = 1205:20 EDT.

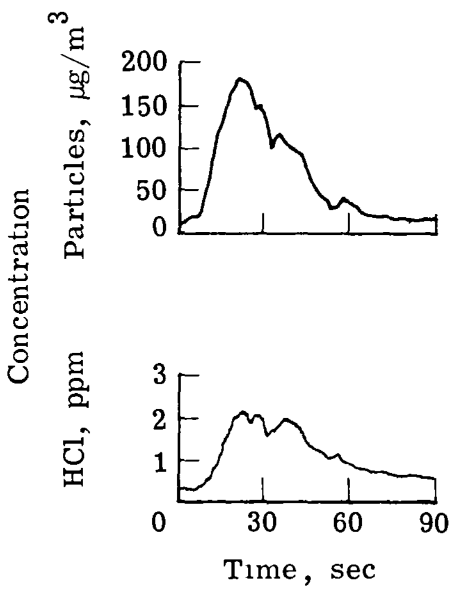
Figure 10.- Continued.



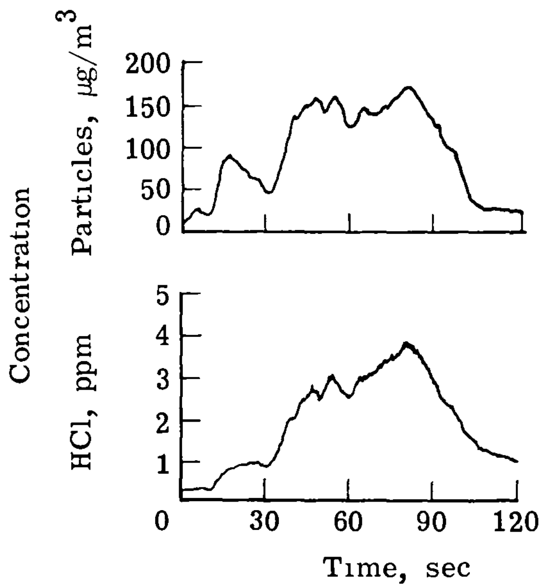
(ee) Pass 31; t_0 = 1210:10 EDT.



(ff) Pass 32; t_0 = 1211:40 EDT.

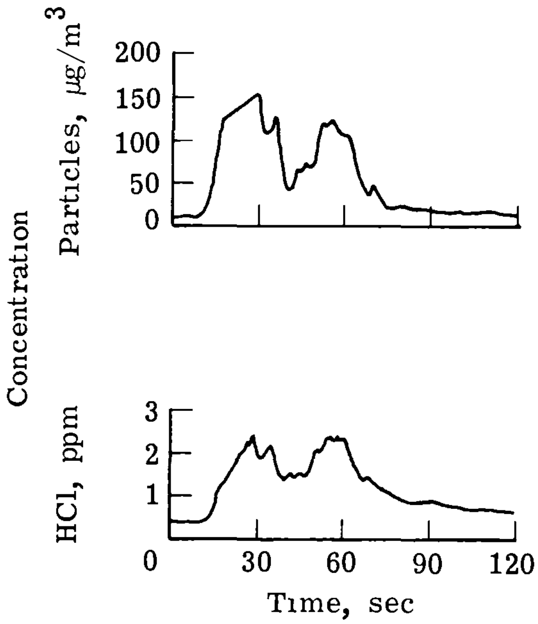


(gg) Pass 33; t_0 = 1216:35 EDT.

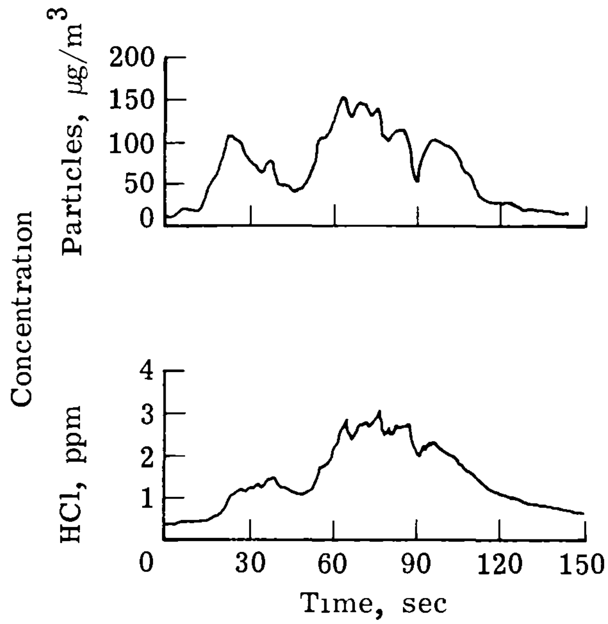


(hh) Pass 34; t_0 = 1222:40 EDT.

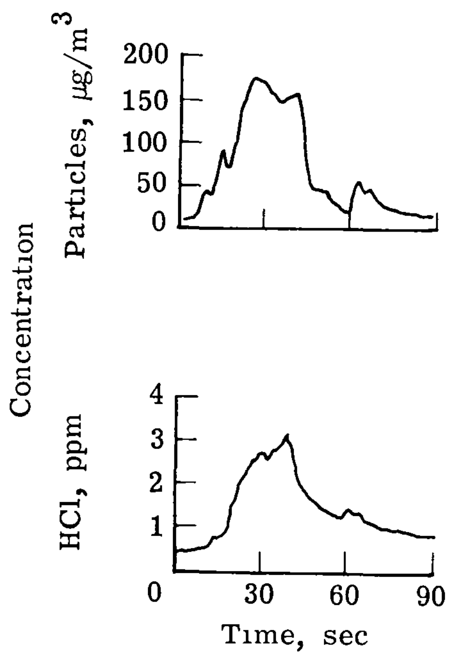
Figure 10.- Continued.



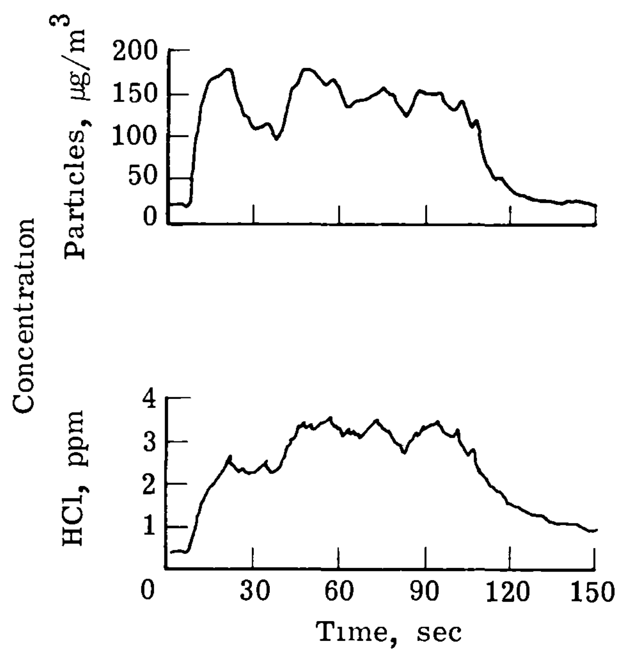
(ii) Pass 35; t_0 = 1226:40 EDT.



(jj) Pass 36; t_0 = 1230:10 EDT.

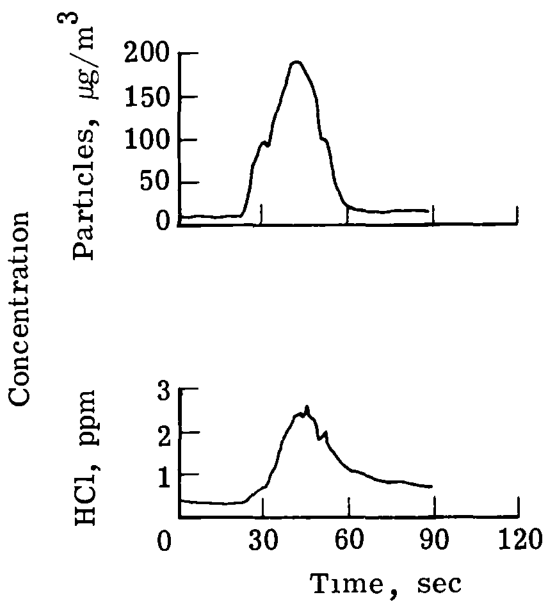


(kk) Pass 37; t_0 = 1234:40 EDT.

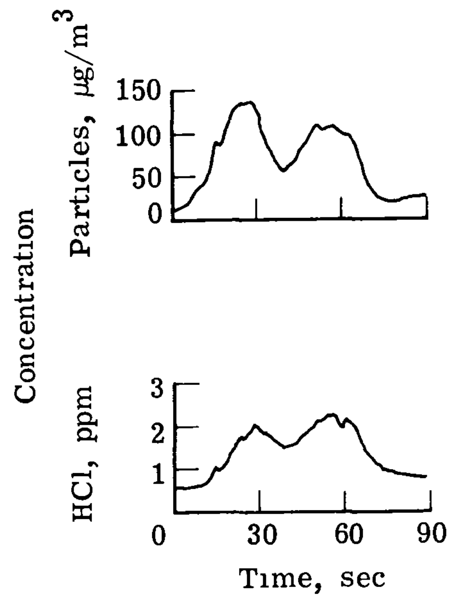


(ll) Pass 38; t_0 = 1238:25 EDT.

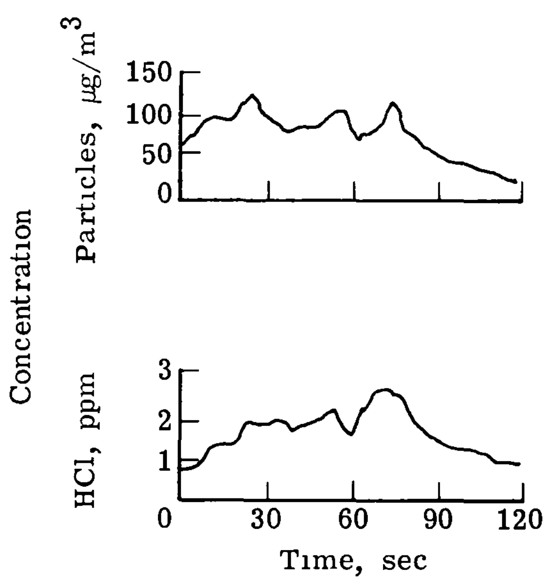
Figure 10.- Continued.



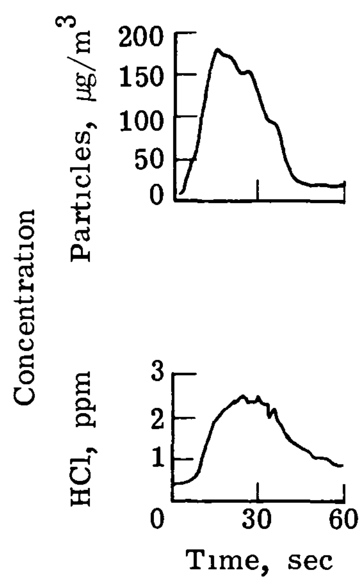
(mm) Pass 39; t_0 = 1243:30 EDT.



(nn) Pass 40; t_0 = 1245:25 EDT.

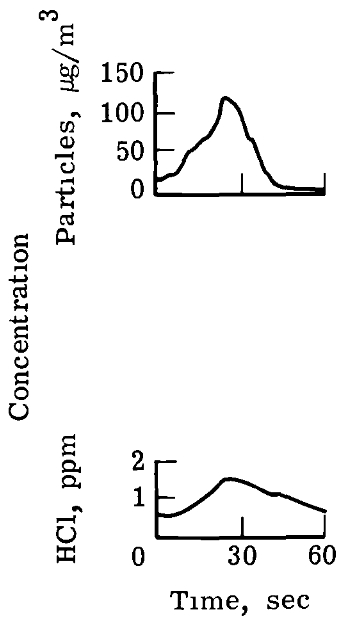


(oo) Pass 41; t_0 = 1247:30 EDT.

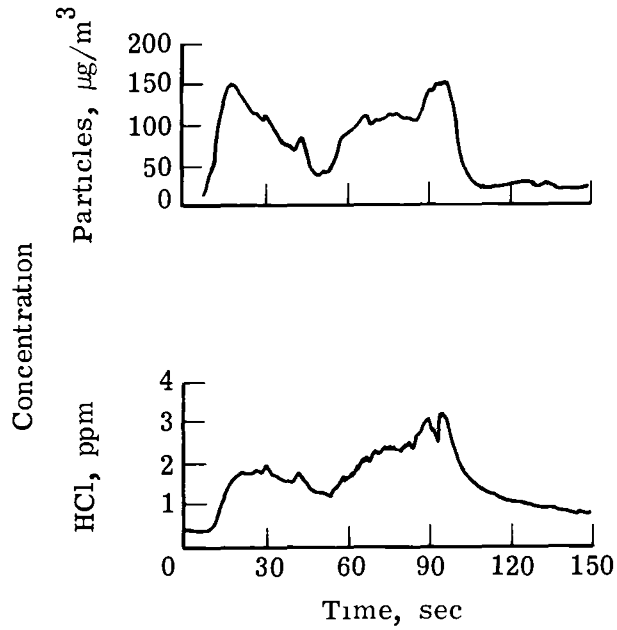


(pp) Pass 42; t_0 = 1251:35 EDT.

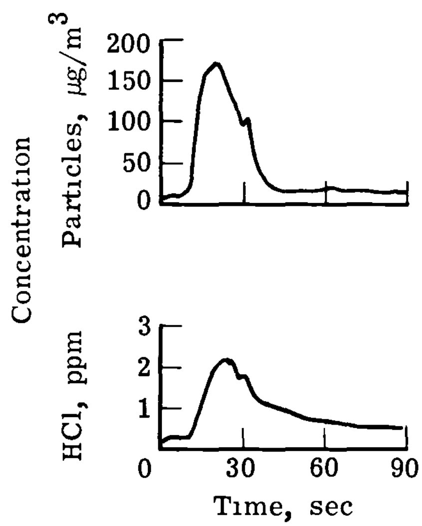
Figure 10.- Continued.



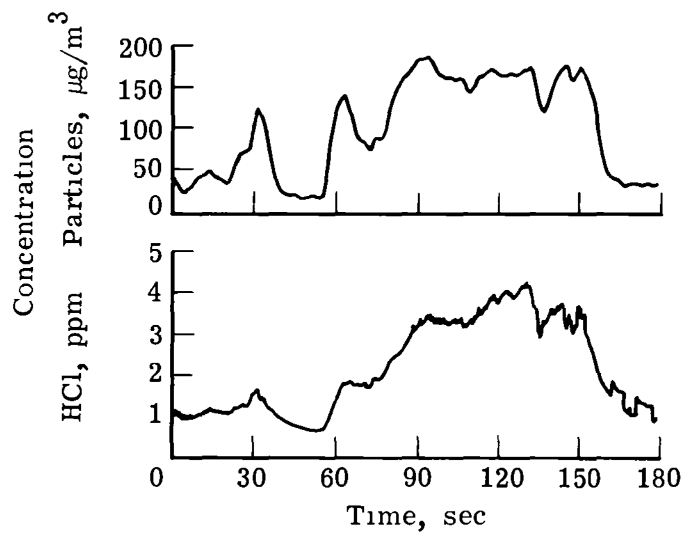
(qq) Pass 43; t_0 = 1253:25 EDT.



(rr) Pass 44; t_0 = 1256:15 EDT.

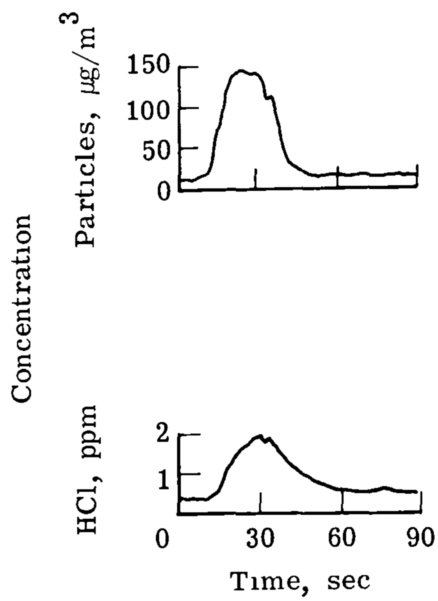


(ss) Pass 45; t_0 = 1301:35 EDT.

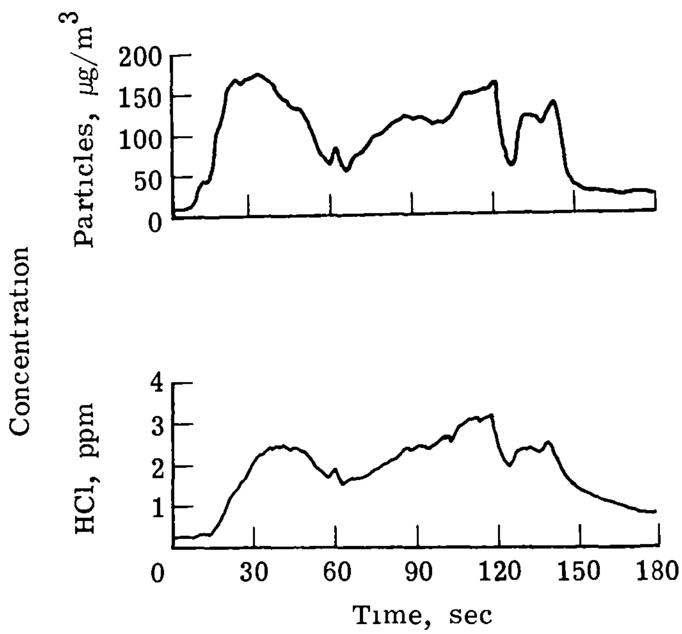


(tt) Pass 46; t_0 = 1303:50 EDT.

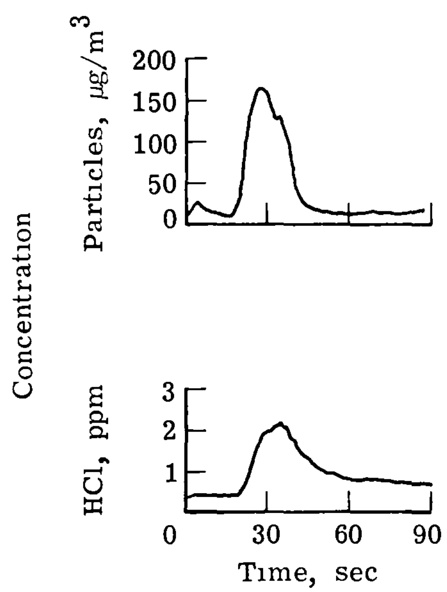
Figure 10.- Continued.



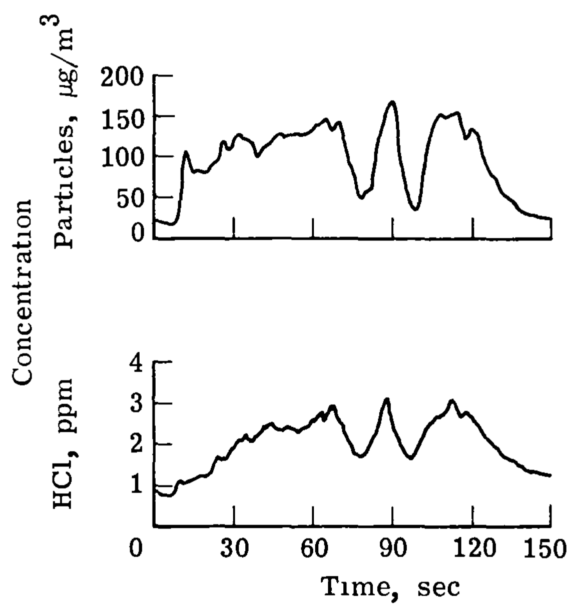
(uu) Pass 47; t_0 = 1309:45 EDT.



(vv) Pass 48; t_0 = 1314:25 EDT.



(ww) Pass 49; t_0 = 1319:20 EDT.



(xx) Pass 50; t_0 = 1322:10 EDT.

Figure 10.- Concluded.

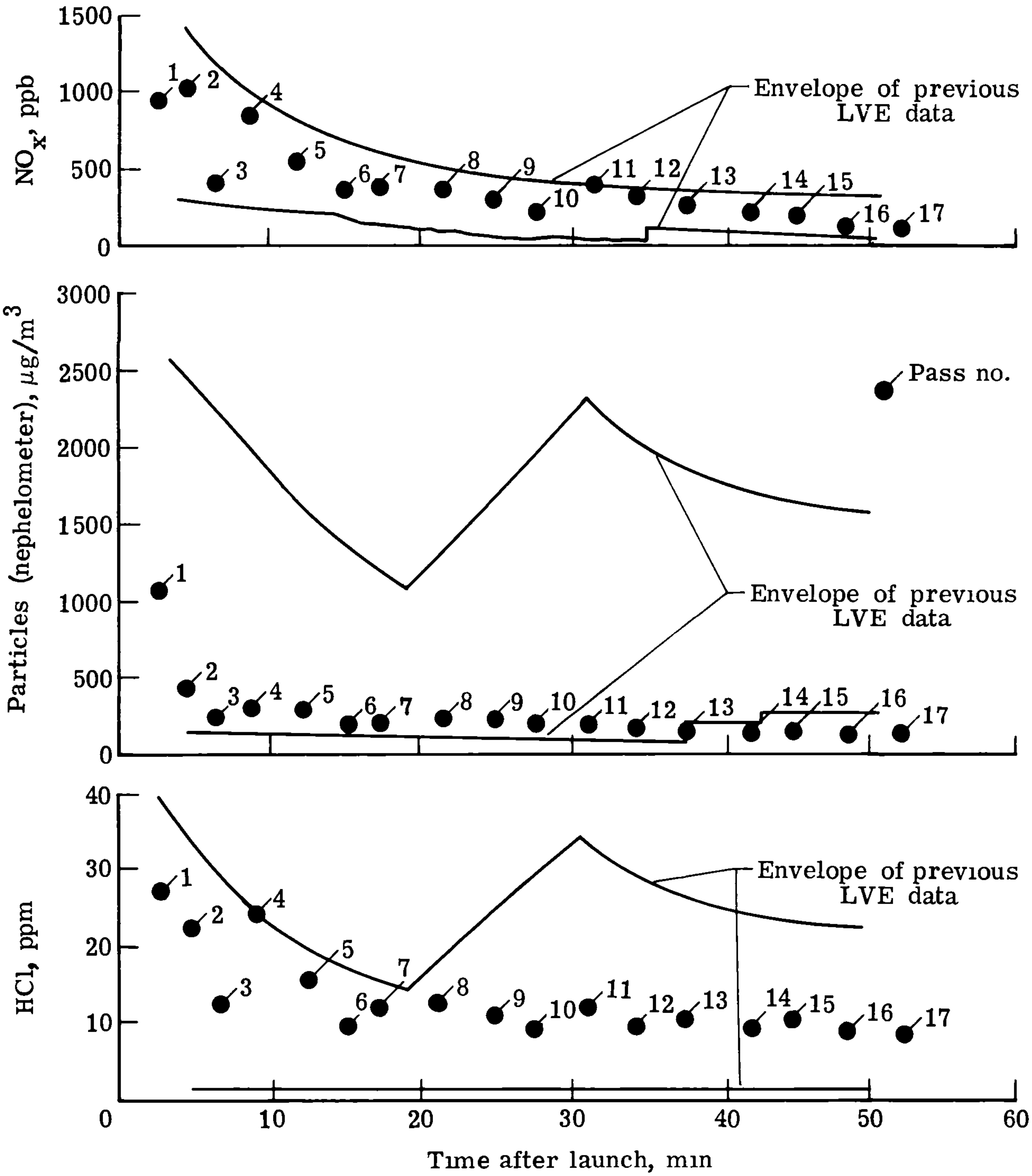


Figure 11.- Comparison of maximum concentration for September 5, 1977, launch with previous LVE measurements (1974 to 1977).

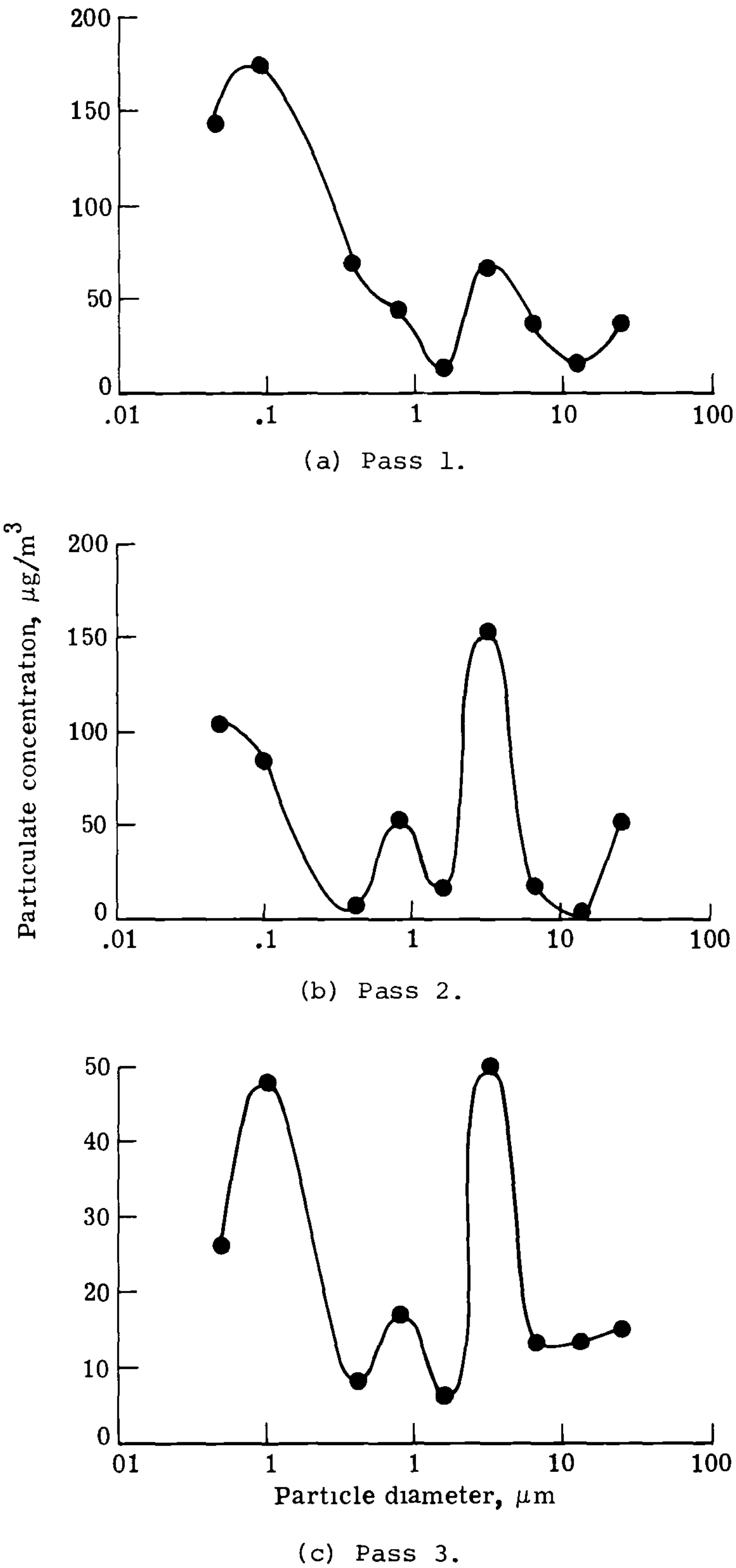
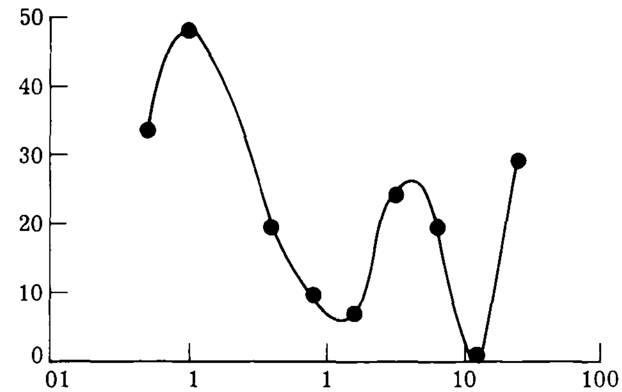
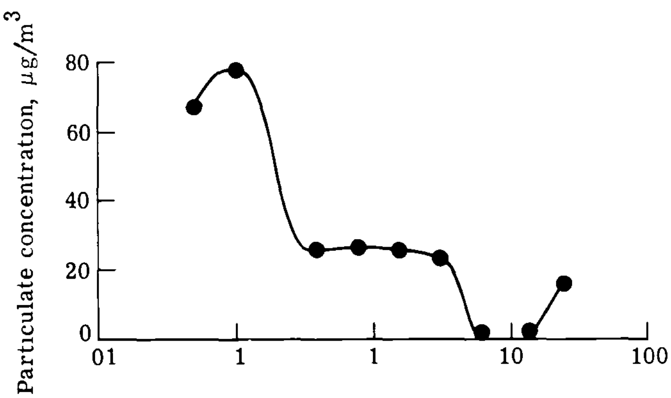


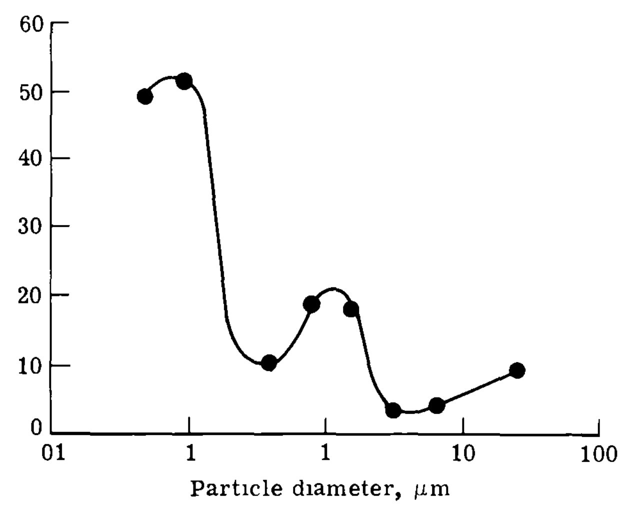
Figure 12.- QCM sizing data.



(d) Pass 4.

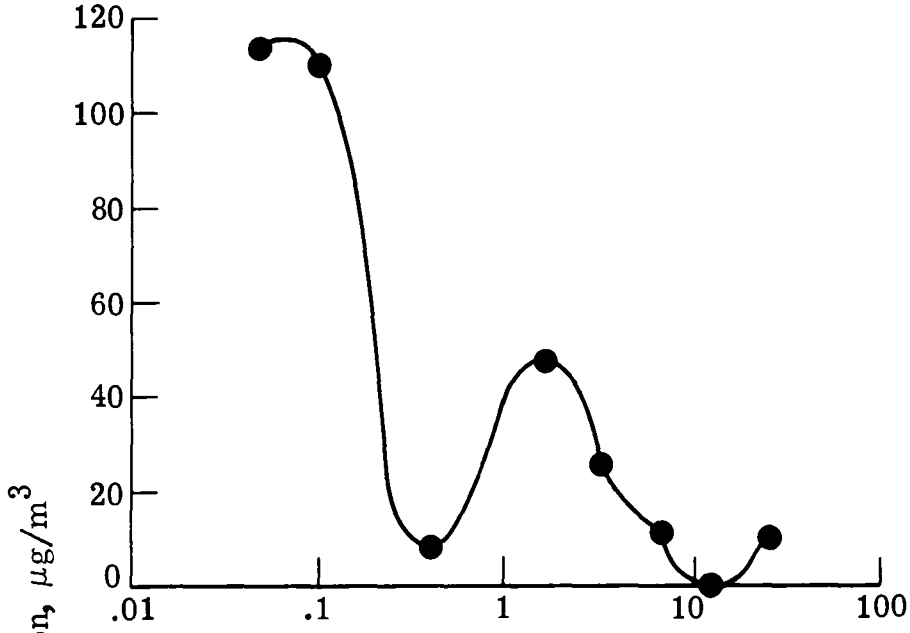


(e) Pass 5.

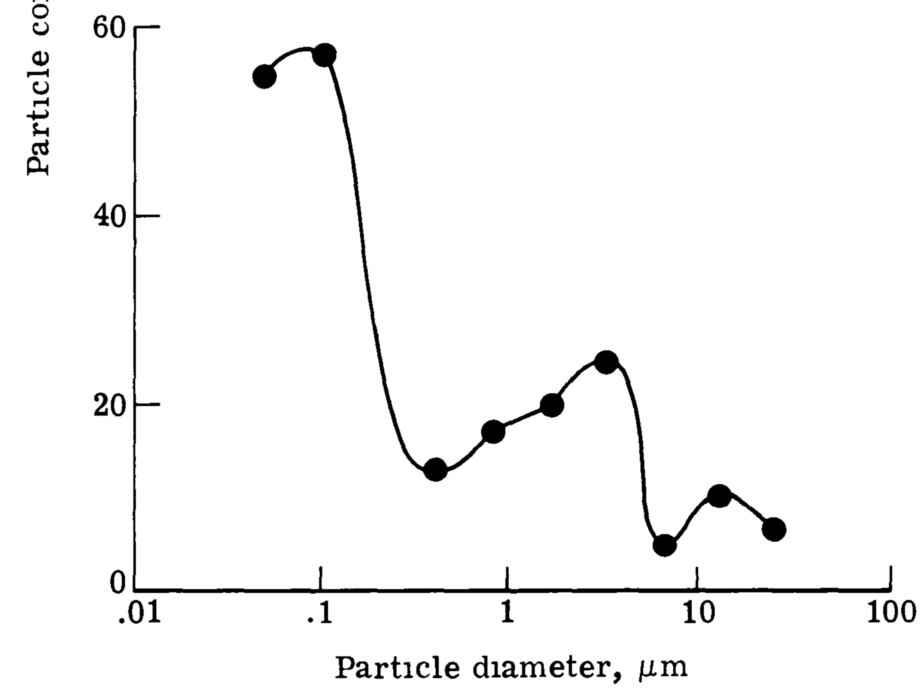


(f) Pass 6.

Figure 12.- Continued.

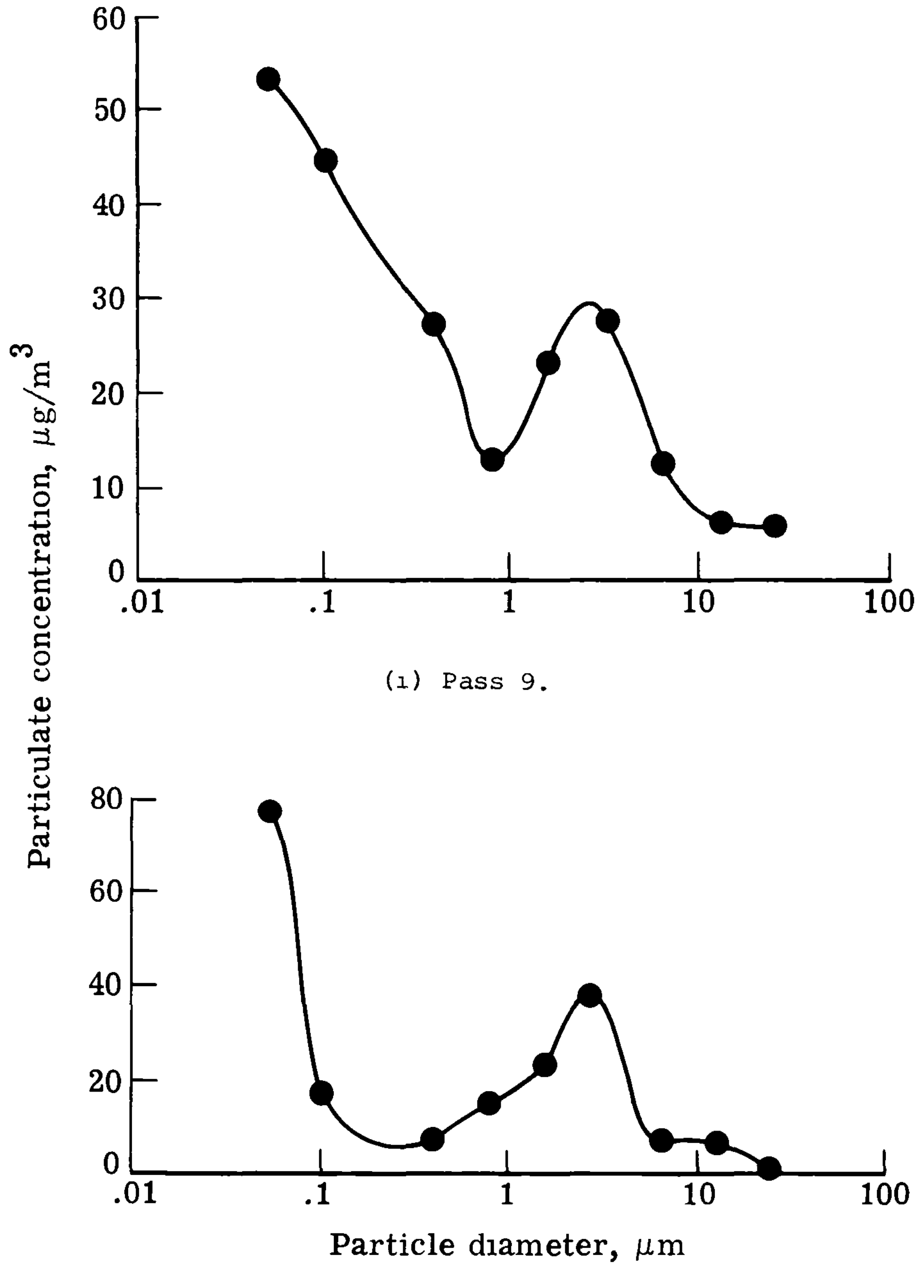


(g) Pass 7.



(h) Pass 8.

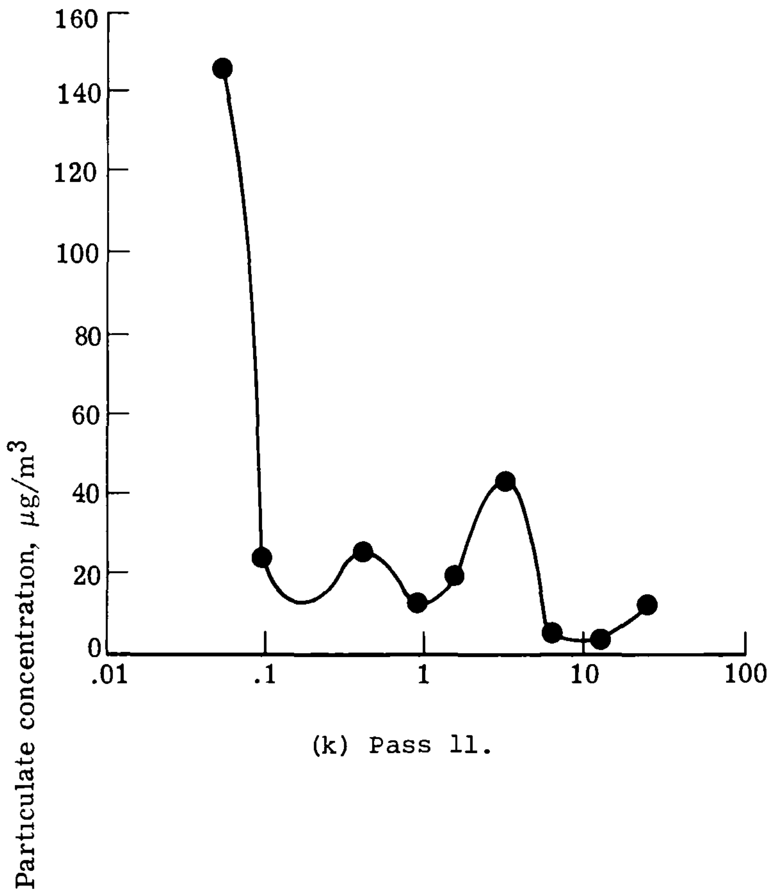
Figure 12.- Continued.



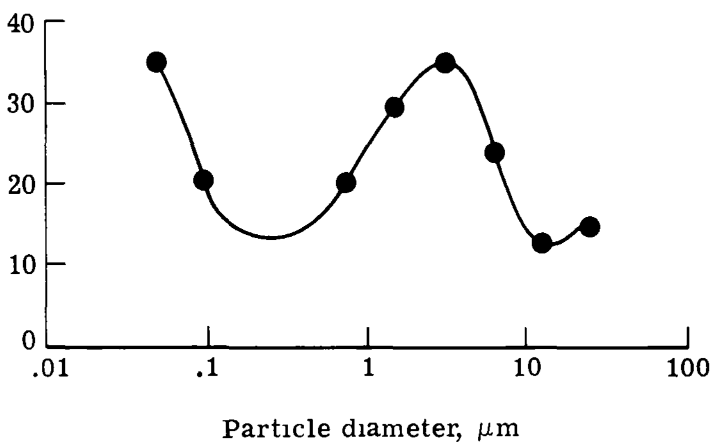
(i) Pass 9.

(j) Pass 10.

Figure 12.- Continued.

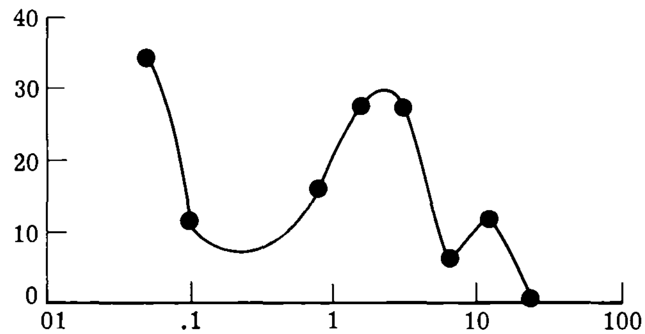


(k) Pass 11.

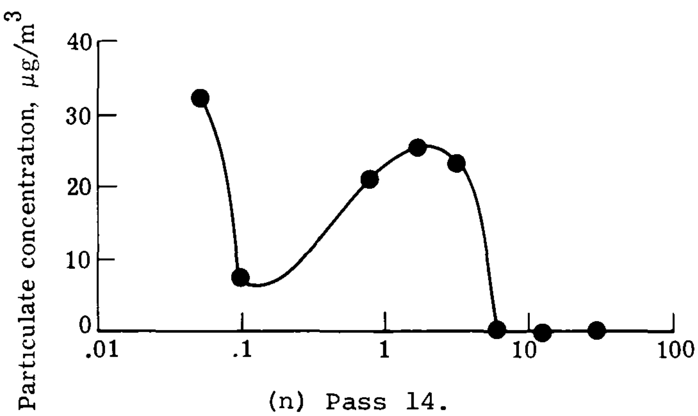


(l) Pass 12.

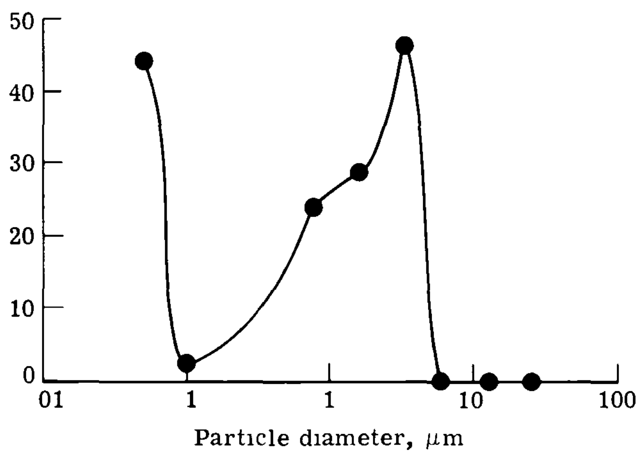
Figure 12.- Continued.



(m) Pass 13.



(n) Pass 14.



(o) Pass 15.

Figure 12.- Concluded.

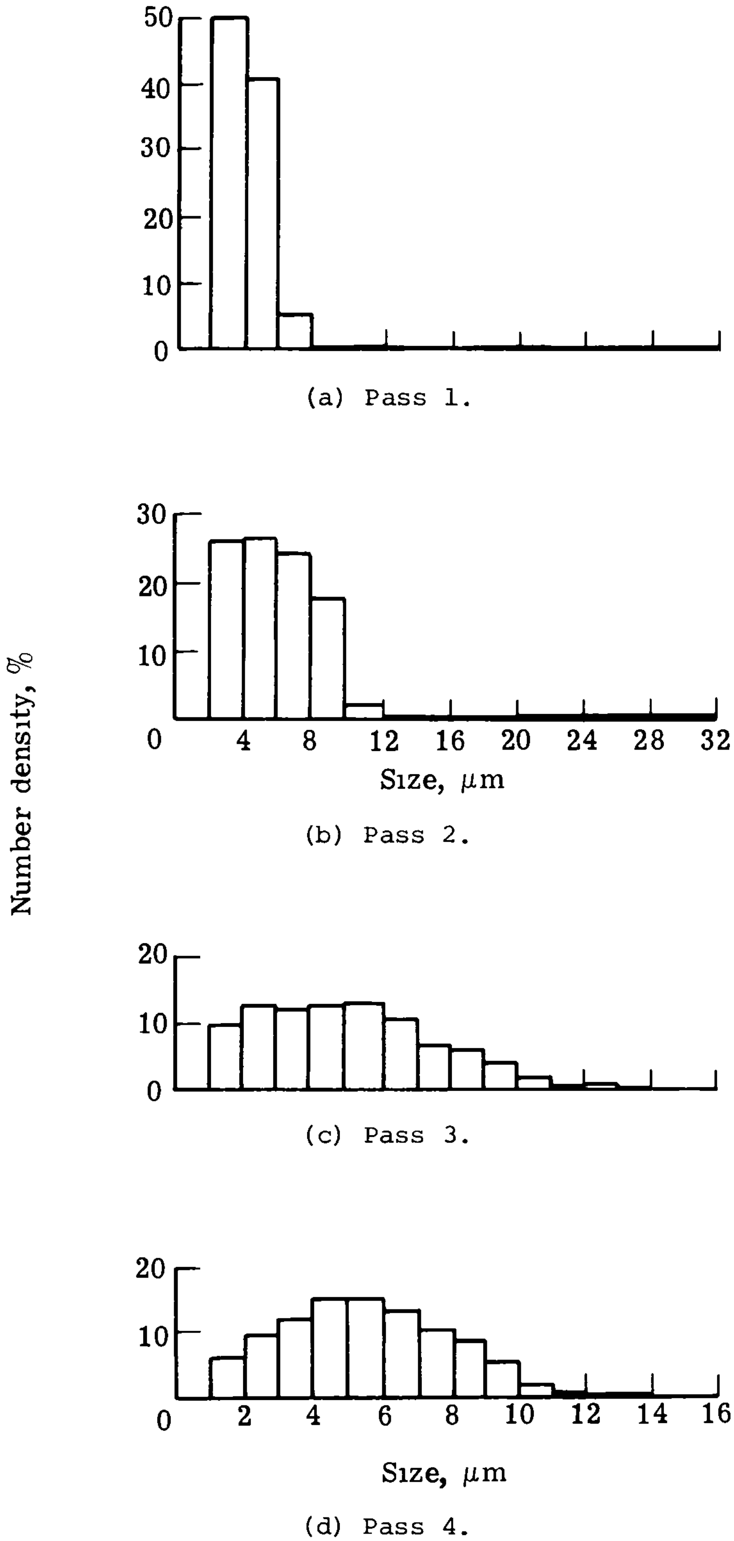
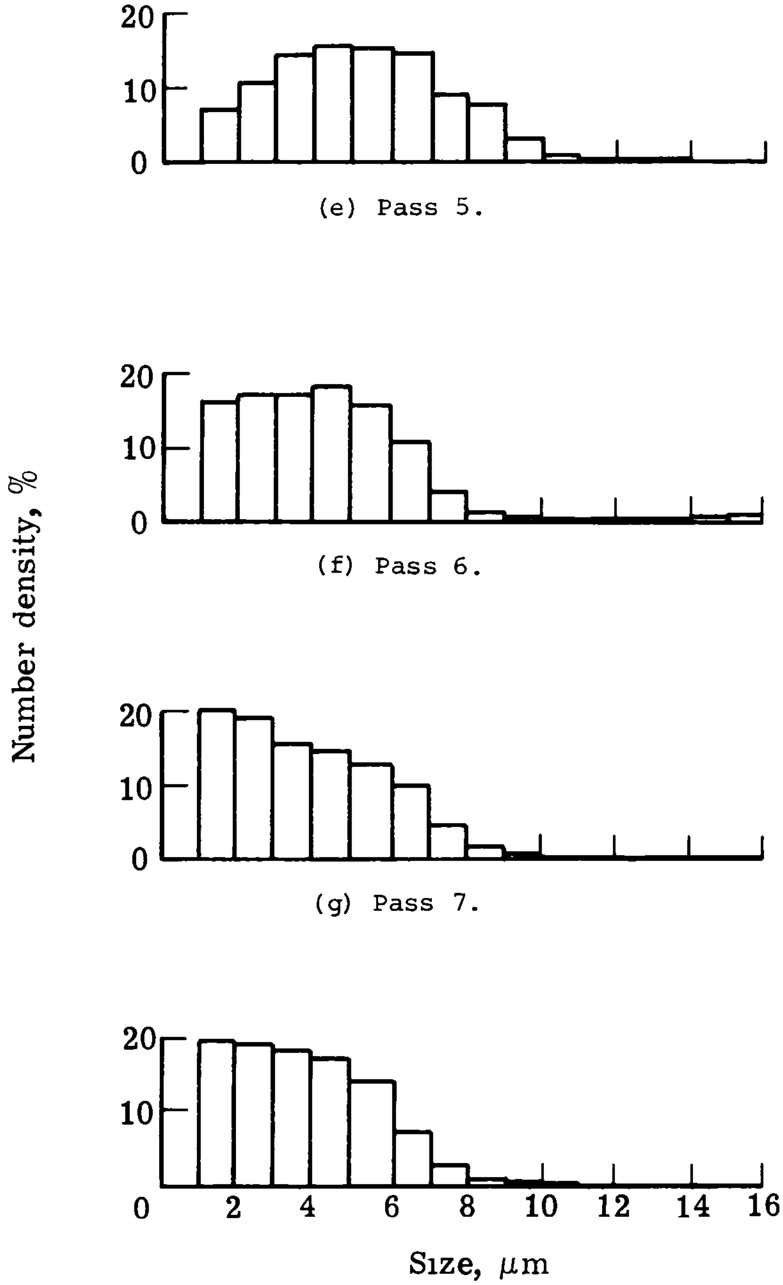
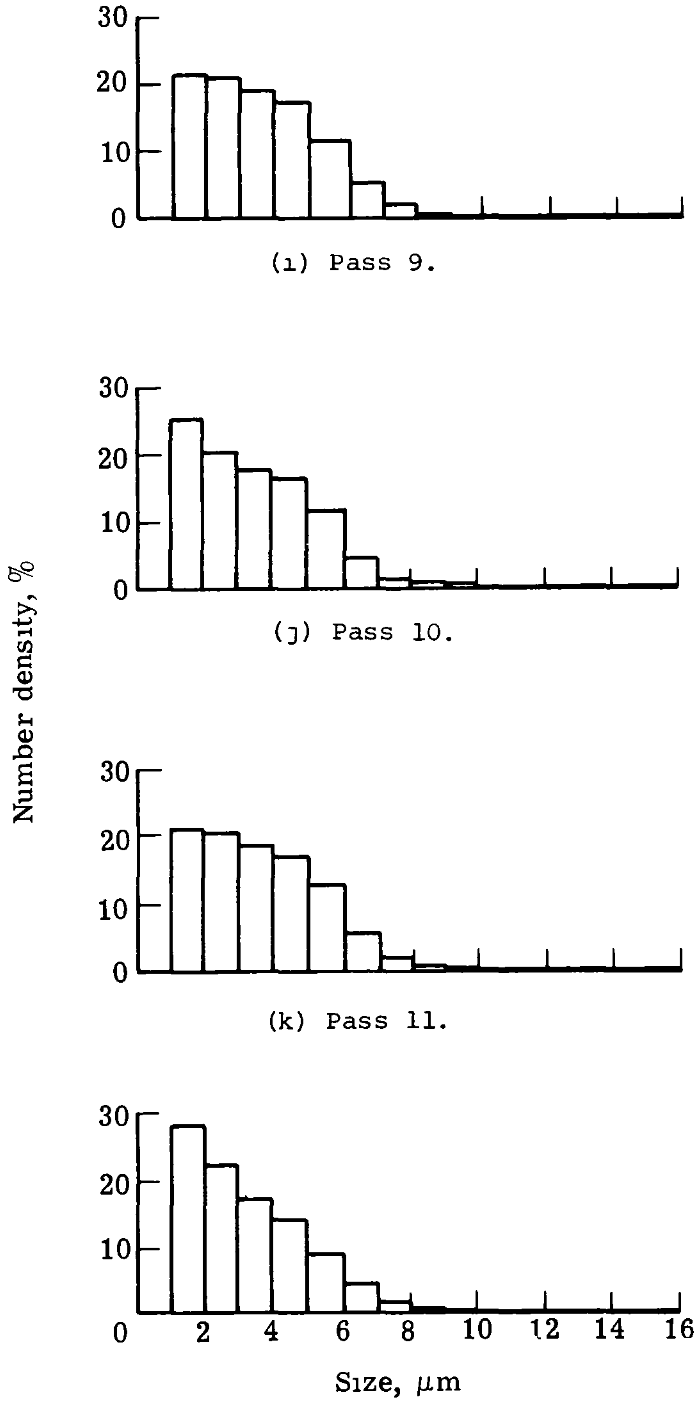


Figure 13.- FSSP data.



(h) Pass 8.

Figure 13.- Continued.



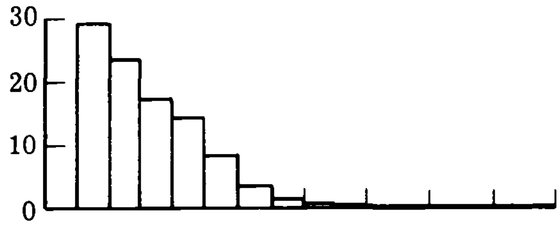
(i) Pass 9.

(j) Pass 10.

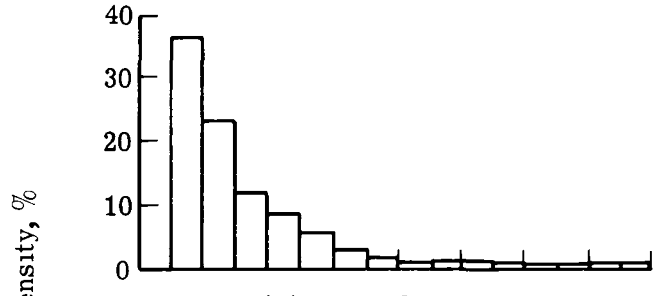
(k) Pass 11.

(l) Pass 12.

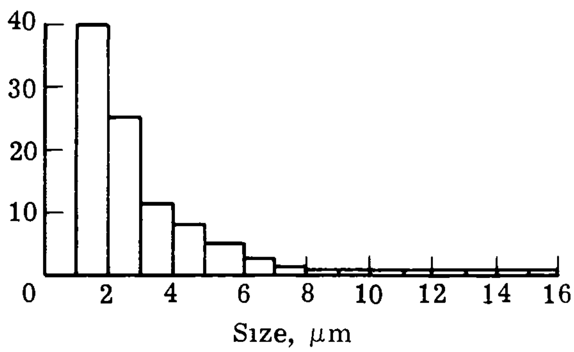
Figure 13.- Continued.



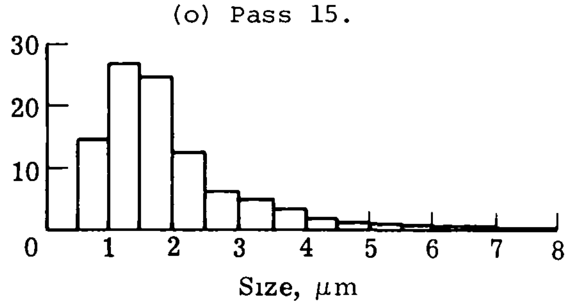
(m) Pass 13.



(n) Pass 14.



(o) Pass 15.



(p) Pass 16.

Figure 13.- Continued.

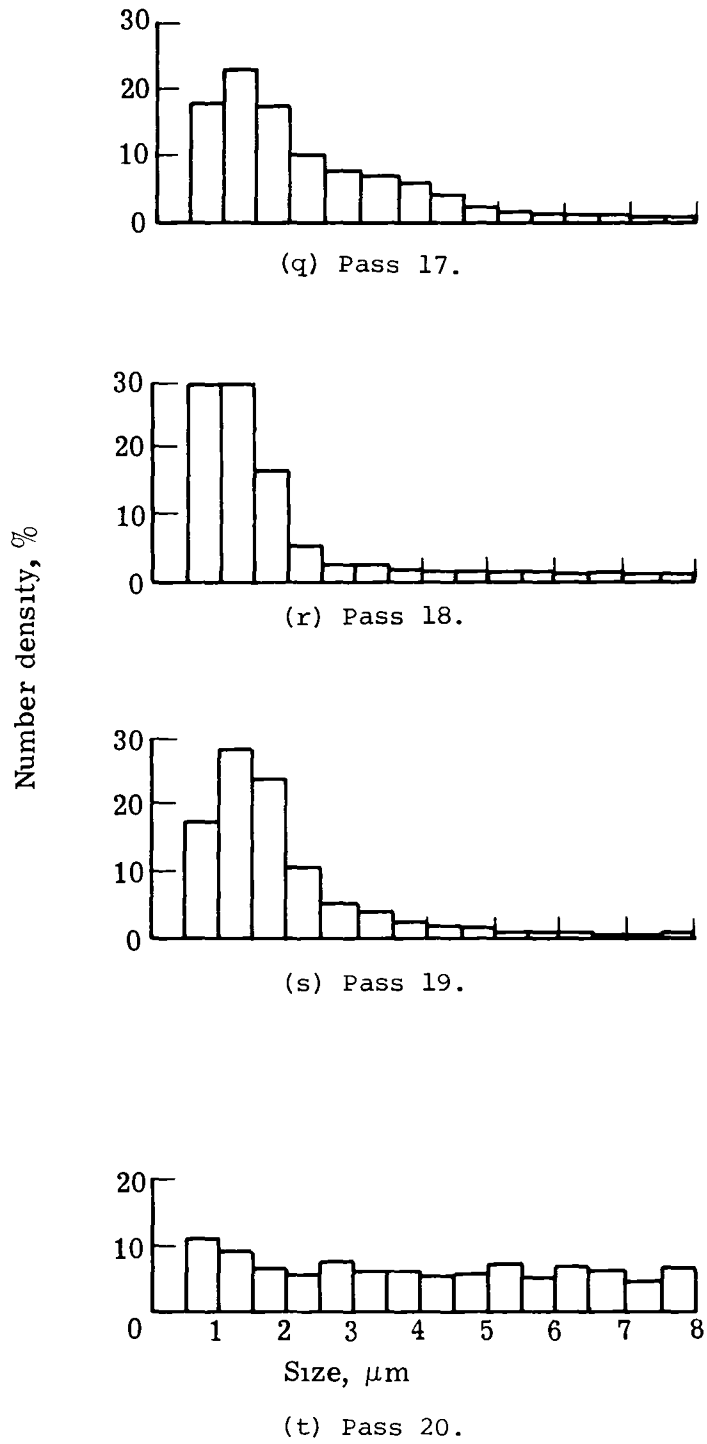
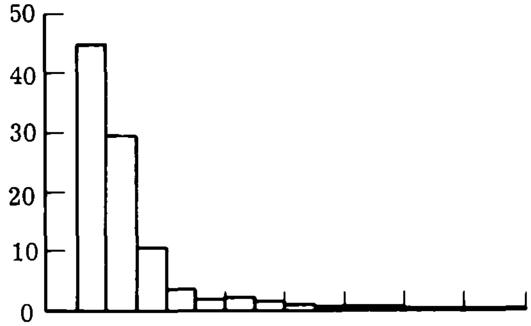
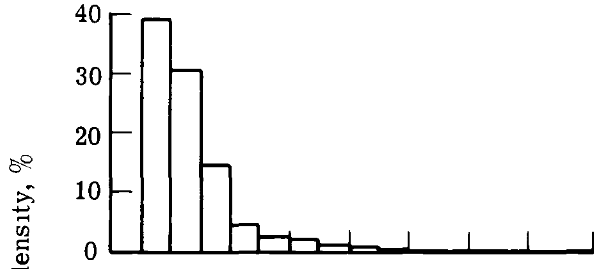


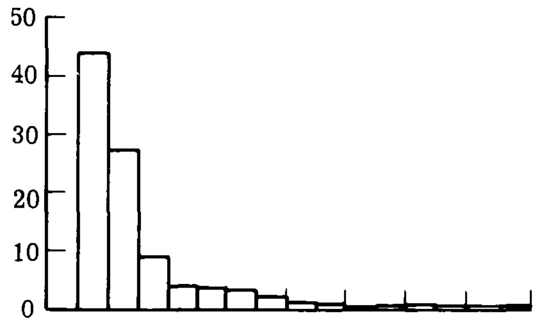
Figure 13.- Continued.



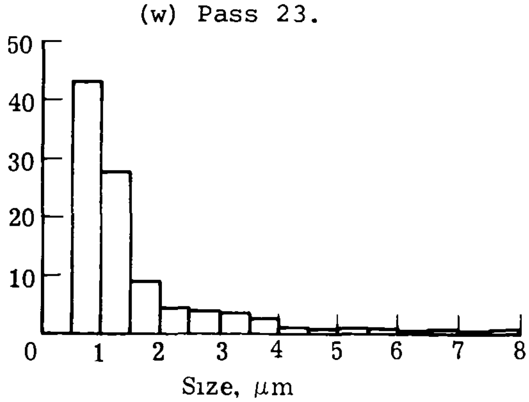
(u) Pass 21.



(v) Pass 22.

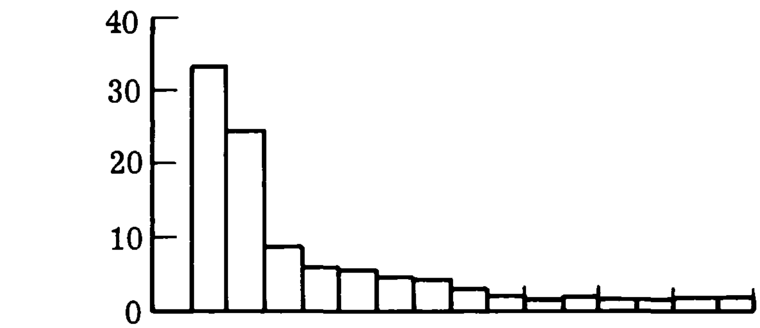


(w) Pass 23.

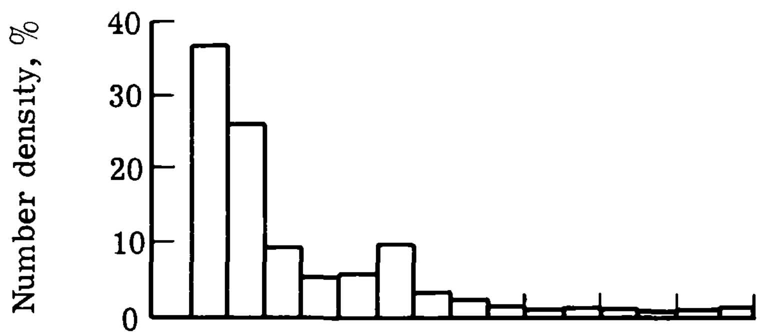


(x) Pass 24.

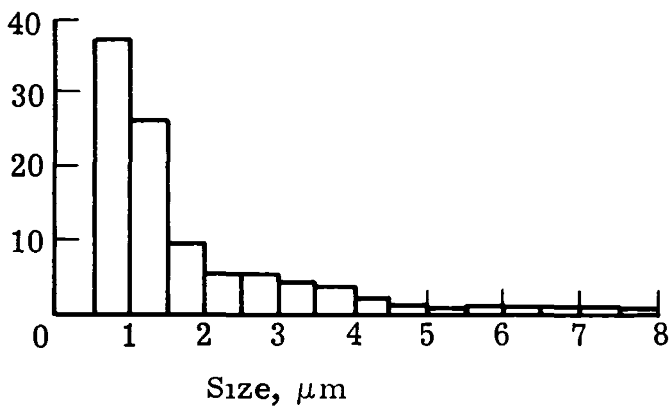
Figure 13.- Continued.



(y) Pass 25.

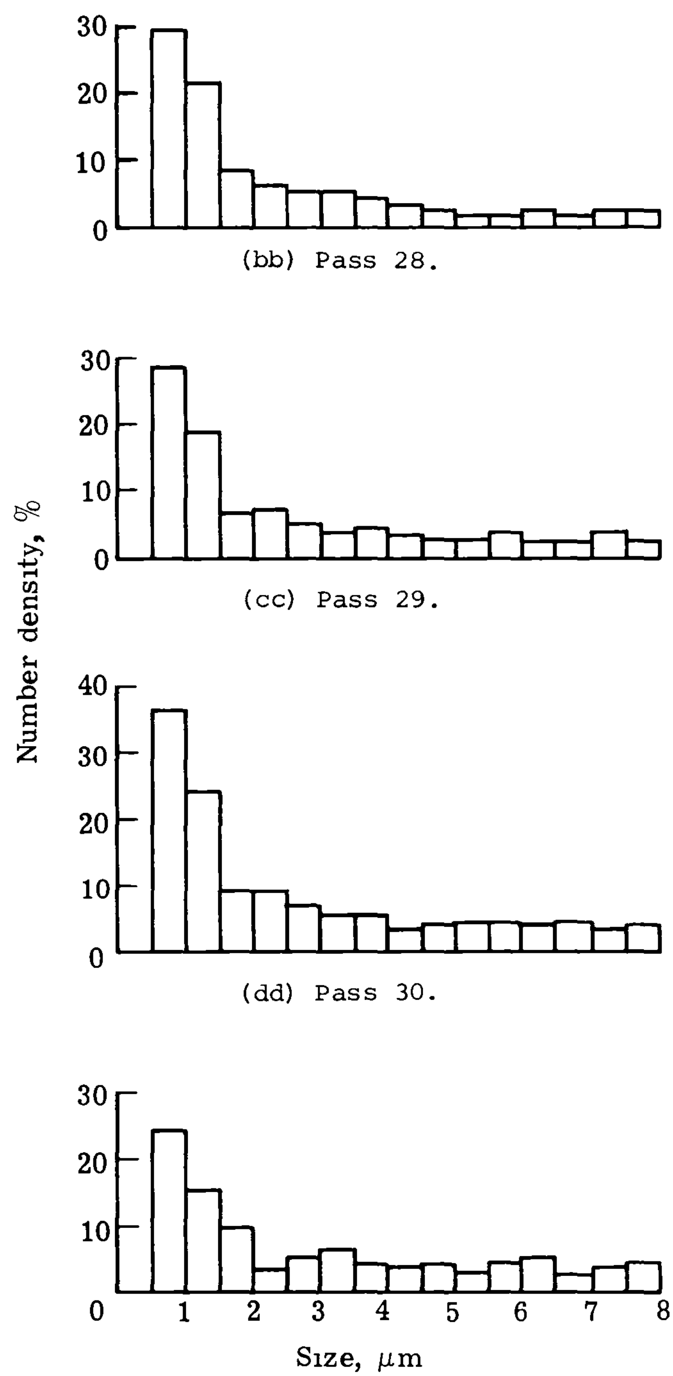


(z) Pass 26.



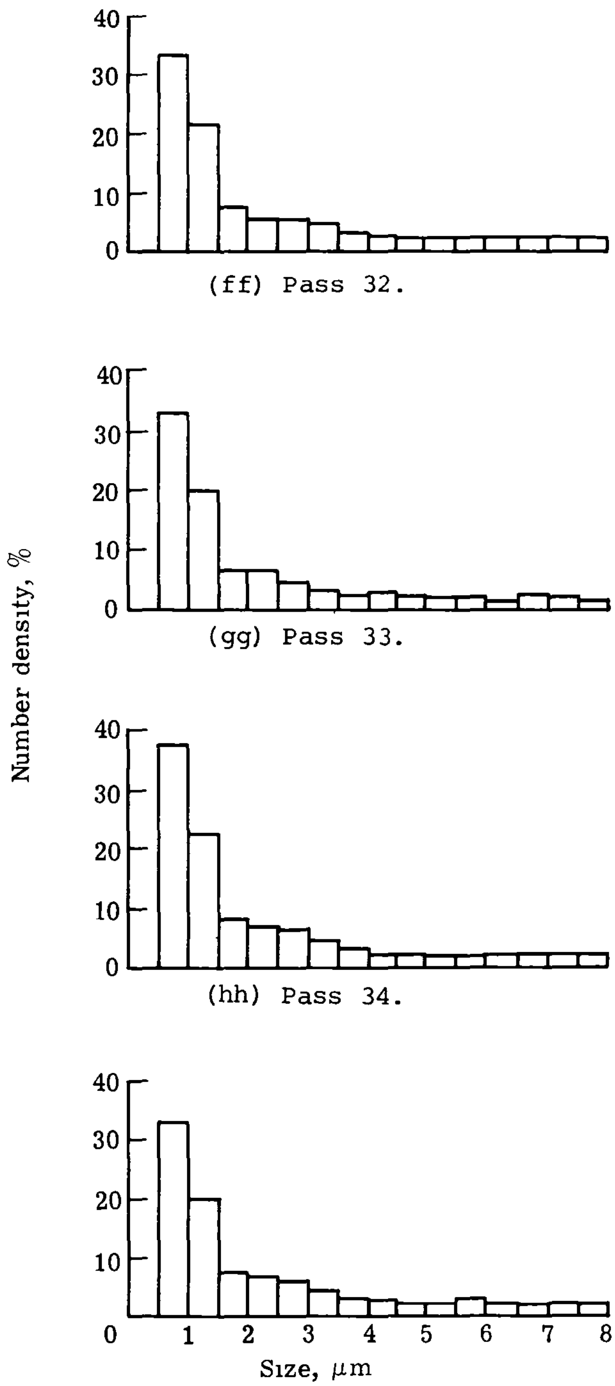
(aa) Pass 27.

Figure 13.- Continued.



(ee) Pass 31.

Figure 13.- Continued.



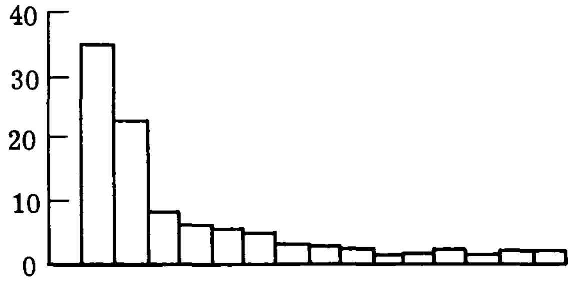
(ff) Pass 32.

(gg) Pass 33.

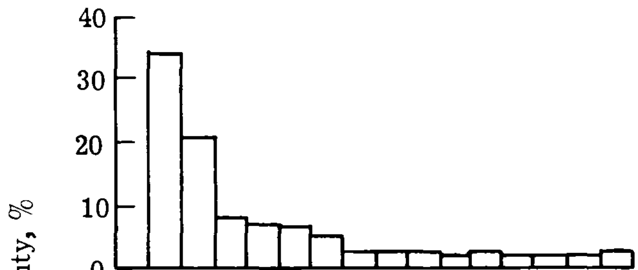
(hh) Pass 34.

(ii) Pass 35.

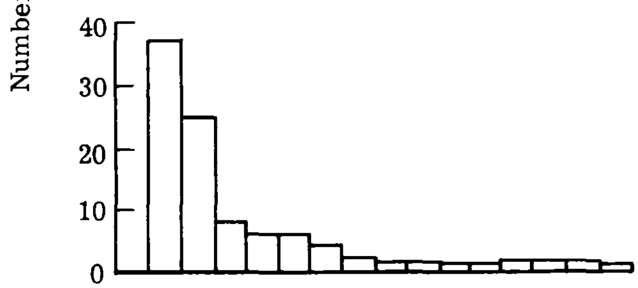
Figure 13.- Continued.



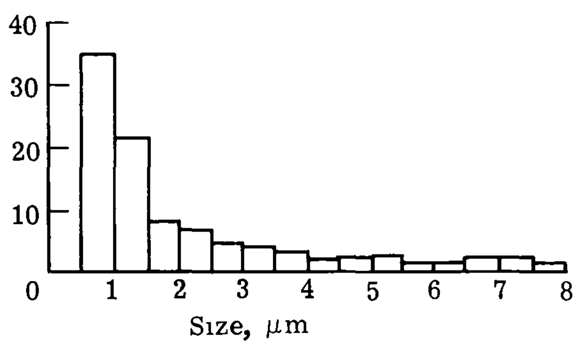
(jj) Pass 36.



(kk) Pass 37.

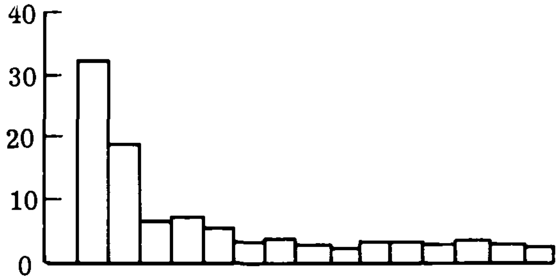


(ll) Pass 38.

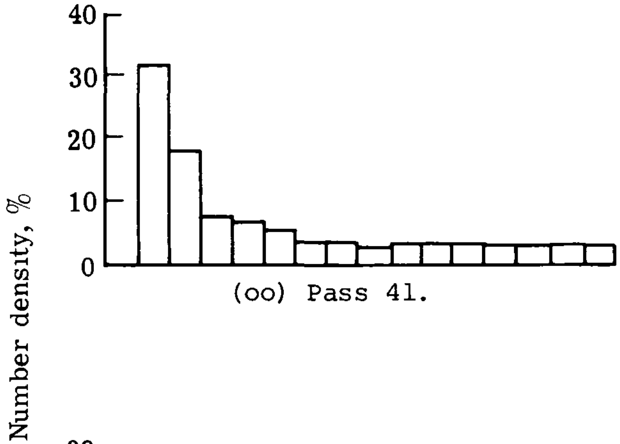


(mm) Pass 39.

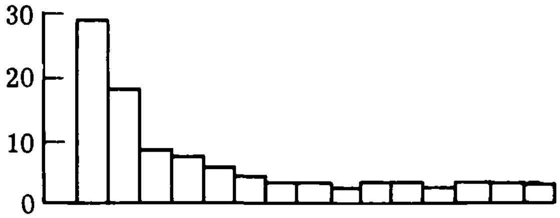
Figure 13.- Continued.



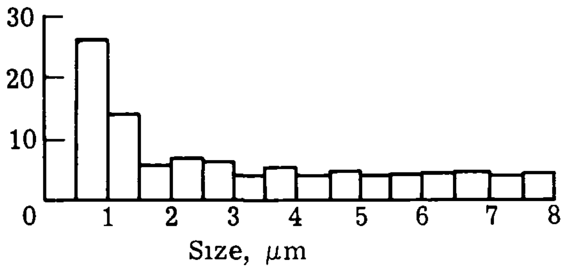
(nn) Pass 40.



(oo) Pass 41.

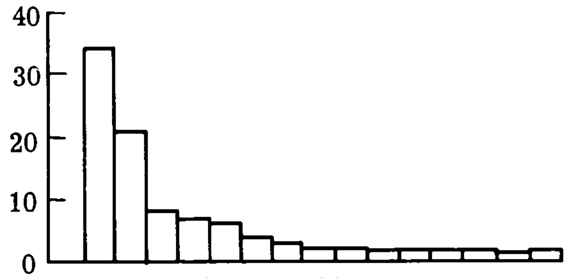


(pp) Pass 42.

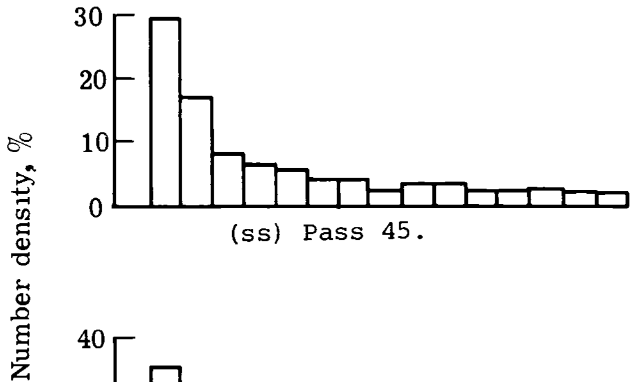


(qq) Pass 43.

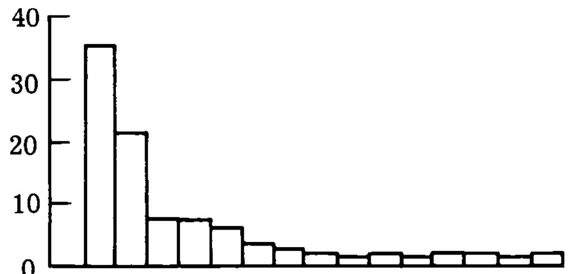
Figure 13.- Continued.



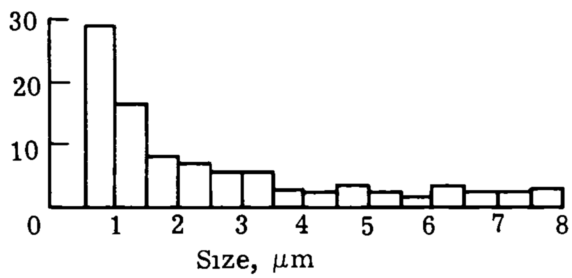
(rr) Pass 44.



(ss) Pass 45.

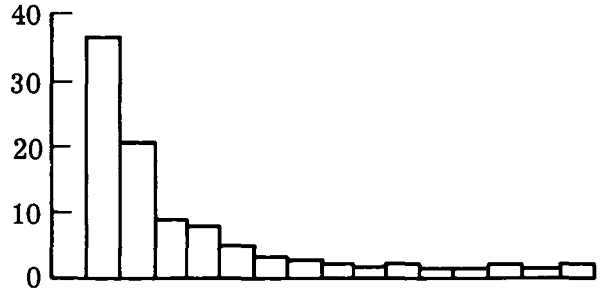


(tt) Pass 46.

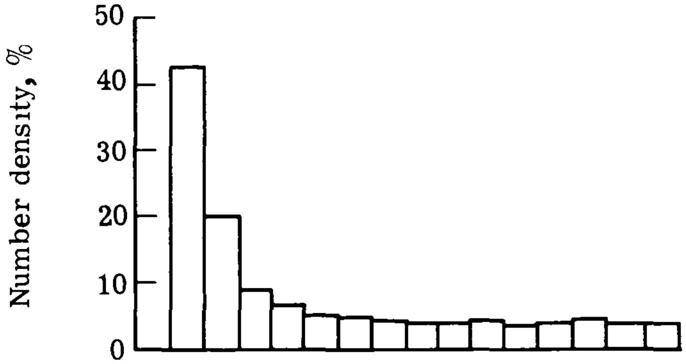


(uu) Pass 47.

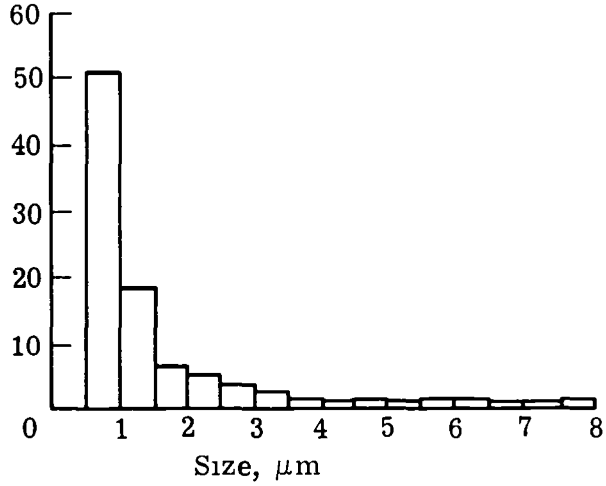
Figure 13.- Continued.



(vv) Pass 48.



(ww) Pass 49.



(xx) Pass 50.

Figure 13.- Concluded.

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